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SKI TRAILS ON MT. REVELSTOKE

Patterns in the snow made by winter enthusiasts on a British Columbia peak

(SEE INDEX PAGE)

VOLUME 55 • NUMBER 2

NEW YORK • LONDON

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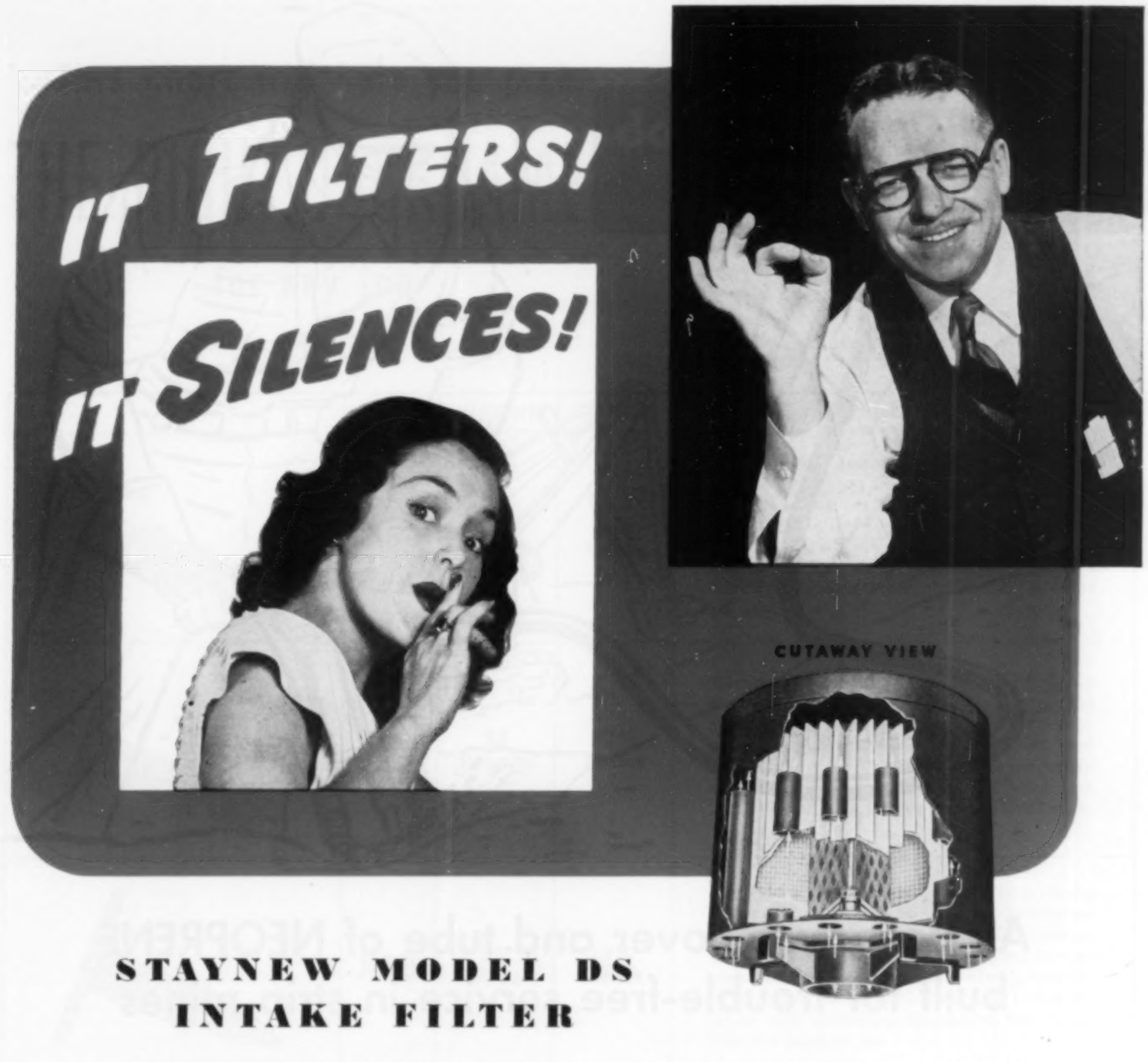
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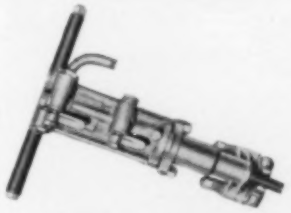	**J-50**	**62½ Pounds**	**23 11/16 Inches**	If it's straight down hole heavy-duty drilling, use the J-50. It is best suited for shaft sinking, excavation, road building and quarry work where holes up to 20 feet in depth are needed in all kinds of rock formations. Many users are also finding the J-50 excellent as a light drifter when long feeds and Carset Jackbits are used.
	J-40	**53 Pounds**	**22⅜ Inches**	Where a lighter weight Jackhamer with plenty of power is required, use the J-40. It readily handles jobs such as heavy duty service in mines, general excavation, trench and road work where the drill must be lifted frequently or carried some distance between holes. Use the J-40 and JL-3 Jackleg for horizontal work.
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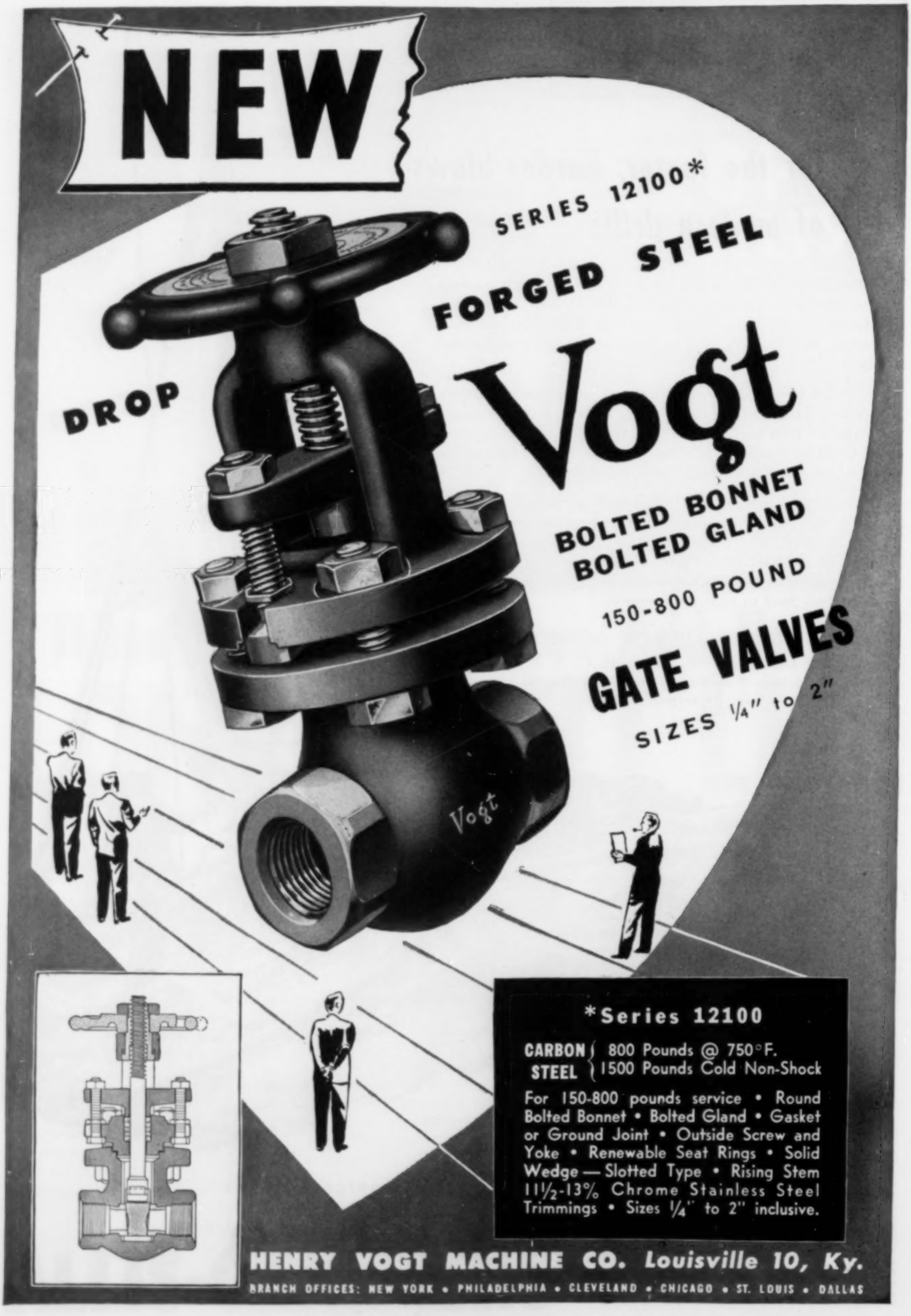

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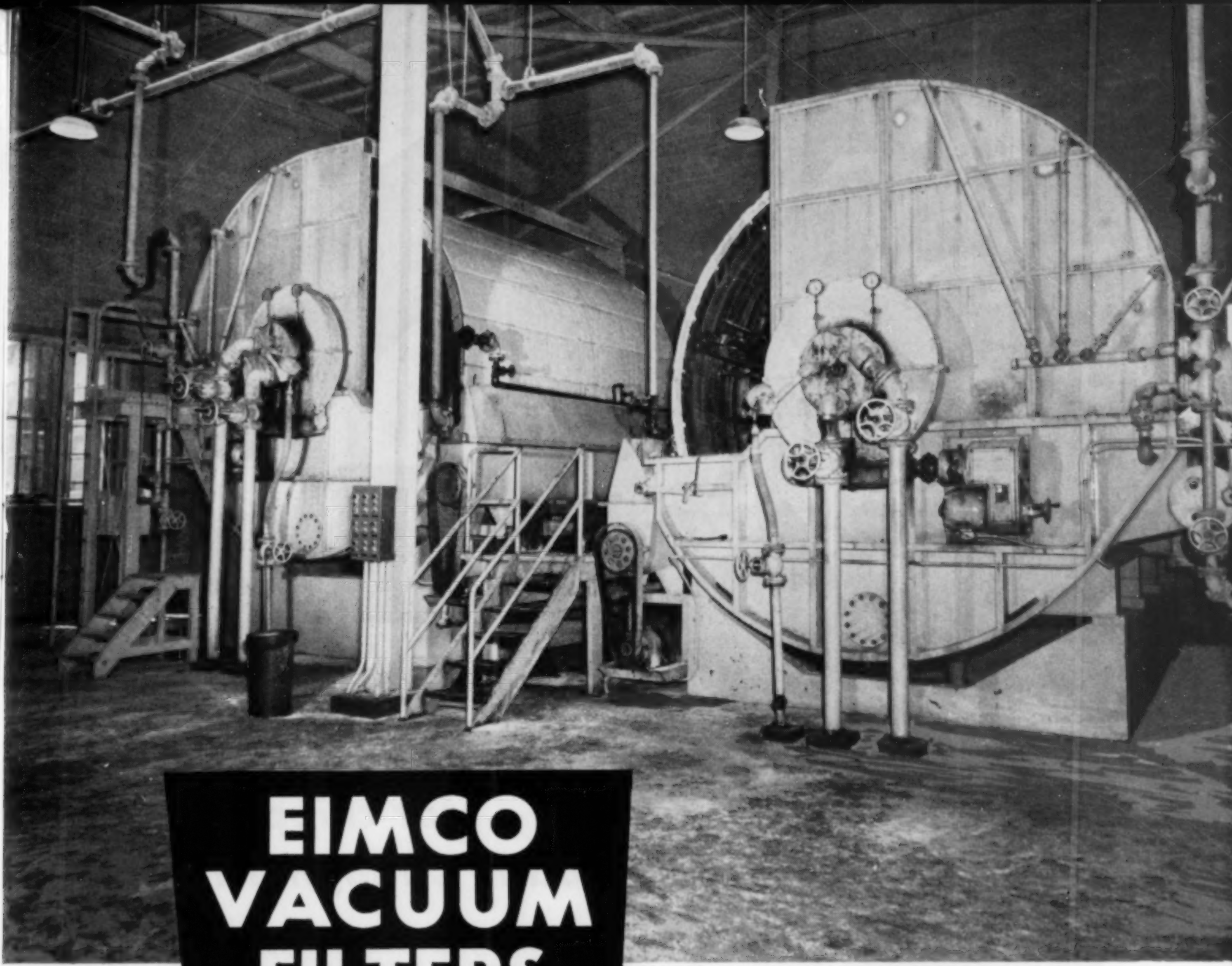

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ON THE COVER

AT THIS season of the year, the outdoors of the northern latitudes beckons to the hardy few, while the many who are not so hardy immure themselves in the comforting warmth of their homes. Although still far fron being classed as a national pastime, skiing is fast gaining new followers among young Americans. With bountiful snowfall, Canada is a mecca for these enthusiasts. Our cover picture shows a winter playground in Mt. Revelstoke National Park.

●

IN THIS ISSUE

OUR leading article describes an application of a new method of grinding materials to impalpable size. In principle, it is very simple. Relatively small pieces of the substance to be pulverized are subjected to the turbulence created by directing multiple jets of compressed air into a confined space from different angles. Hurtled about in this maelstrom, the flying pieces collide over and over again until they wear one another down. Putting the principle to work was not so easy, but engineering ingenuity solved the attendant problems, and grinding with air is now a commercial reality. The new technique has numerous possible industrial applications other than the one reviewed.

●

IT IS a maxim of the oil and gas industries that production machinery must be capable of running virtually without shutdown. A natural-gas transmission line, for example, operates continuously, and the compressors that boost the pressure of the gas are called upon to function weeks or months at a time. To meet this requirement, manufacturers have developed machines of great dependability. As safeguards, they equip them with devices that will shut them down if any of the more usual troubles arise. Users of these compressors have come to place such trust in them that completely unattended operating stations are beginning to appear. One of them is described in the article that starts on page 39.

●

THE world has obtained its time from Greenwich, England, in the London metropolitan area since 1878. It will continue to do so in name but not in fact, for the famous astronomical observatory is moving from its traditional site. In their new location in Sussex, the observers will be able to train their telescopes on the stars without the impeding blanket of London fog and smoke. Adjustments will be made in determining time to permit sending it out, as before, as Greenwich mean time. Page 45.

Compressed Air Magazine

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Grinding Talc to Superfine Size

A New York Producer Uses Blasts of Compressed Air in a New Type of Grinding Mill to Turn Out Tiny Mineral Particles by the Carload

Walter P. Gillingham

PHOTO, CONWAY & KITTS, GOUVERNEUR, N. Y.

AERIAL VIEW OF PLANT

This panorama of the Gouverneur Talc Company surface structures shows the mine headframe at the left, the hoist house half hidden by trees in the center foreground, and the milling plant at the right. Ore hoisted from the mine passes through a gyratory crusher in the headframe, and is then conveyed on a covered belt to air-powered grinding mills which reduce it to micron and submicron sizes. The cylindrical structures at the milling plant are bins or silos used for storage of wet ore from the mine, dried and crushed ore, or finely ground talc.

"MISTER, those new fellows are grinding talc so fine you can't even see it when they get through. And they're not doing it with regular grinding mills, either. They're doing it with air." Residents of the Gouverneur talc-mining district in upper New York State have been talking like this ever since the summer of 1948 when a new plant built there began to mine and process talc.

Gouverneur Talc Company, Inc., owner and operator of the plant, is reducing talc to micron and submicron sizes in a revolutionary type of air-powered grinding mill. Looking like an oversized doughnut stretched out of shape, the mill has no moving parts. It mixes crushed and dried talc ore with compressed air and lets the pieces knock themselves to bits against one another as they whirl round and round inside of it.

How fine is finely ground talc? Well, the finest grade put out by Gouverneur Talc averages eight-tenths of a micron in diameter. A micron is one one-thousandth of a millimeter or approximately one twenty-five thousandth of an inch. This means that each particle measures only about one thirty-thousandth of an inch across. The smallest one visible to the naked eye has a diameter of around 44 microns. Thus an 0.8-micron particle of talc would have to grow to a size 55 times larger than it is before it could be seen.

Who buys finely ground talc? The paint industry, for one, which mixes it with other pigments to make the best house paints available. Makers of ceramics add it to their products to give them high resistance to heat, acids, thermal shock, and breakage. Cosmetics manufacturers use it for face powder and other toilet preparations. It serves rubber and insecticide makers as a dusting agent and as a filler. Paper, wall plaster, putty, oilcloth, linoleum, composition flooring, rope, string, textiles, and many other products contain varying grades, also as a filler. Talc dust helps to turn out the wire nails you build your house with, the clothes you wear, the candy you eat, and the gum you chew.

Gouverneur Talc Company puts out five different grades of ground talc under the trade name of NYTAL (New York Talc). Three of them—300, 400, and 500—are produced by air-powered mills. The average particle size, as determined by the sedimentation method, is 6.0 microns for the 300 grade, 1.5 microns for the 400 grade, and 0.8 micron for the 500 grade. Those accustomed to classifying ores and other materials according to mesh often find it hard to visualize the extreme smallness of such particles. Mesh means the number of openings per linear inch of screen through which a crushed ore will go. For example, ore crushed to minus 10-mesh size will pass through a screen having ten openings per linear inch or 100 openings per square inch. In standard ore-dressing practice, utilizing mechanical grinding machines, a 200-mesh screen is about the finest used.

In comparison, the particles turned out by Gouverneur Talc make minus 200-mesh material look like boulders. One micron is 12,500 theoretical mesh—theoretical because no one has ever made so fine a screen. The 325-mesh size, through which 99.9 percent of the processed talc must pass, has 44 microns per opening and 105,625 openings per square inch. It is the finest commercial screen available and can hold water without leaking. Yet the talc particles go through with room to spare.

Gouverneur Talc is a subsidiary of R. T. Vanderbilt Company of New York City. It was formed in 1947 when Vanderbilt, an organization with extensive experience in the industrial-minerals field, became interested in a new type of grinding mill just put on the market by C. H. Wheeler Manufacturing Company of Philadelphia. Wheeler had acquired the mill from N. N. Stephanoff, an engineer who spent years developing and perfecting it. When the Wheeler organization took over his mill, Stephanoff joined the company as technical director of its newly created fine-particle-processes department.

Wheeler said that Stephanoff's "fluid

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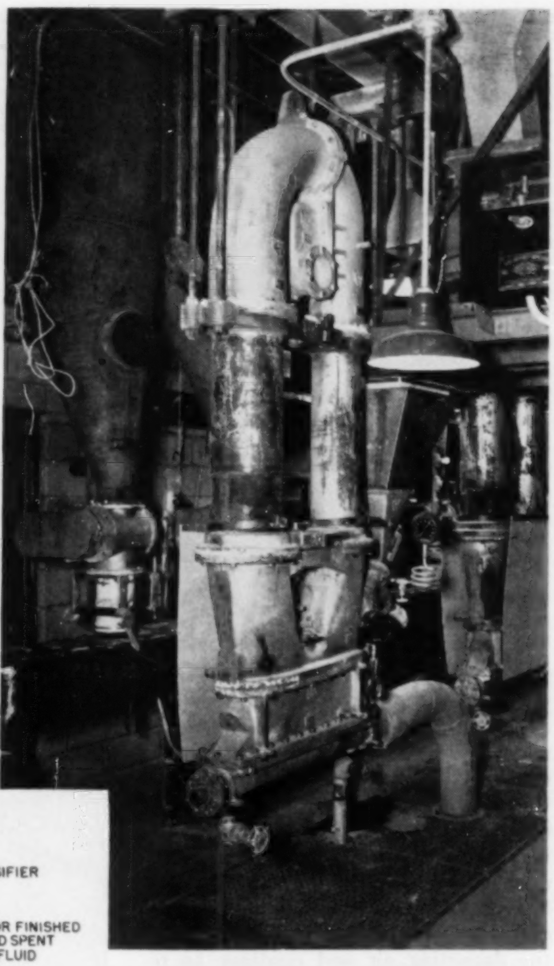


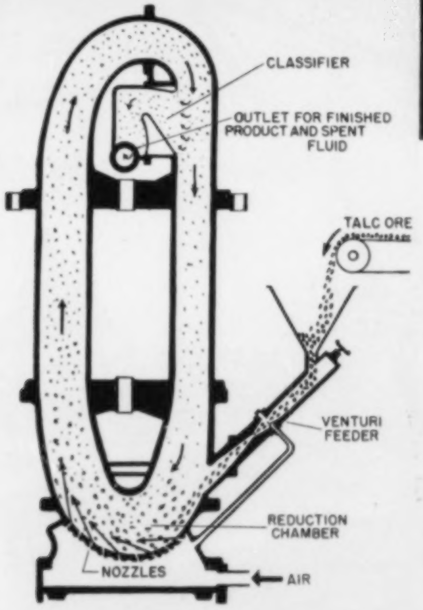
A MILL AND HOW IT WORKS

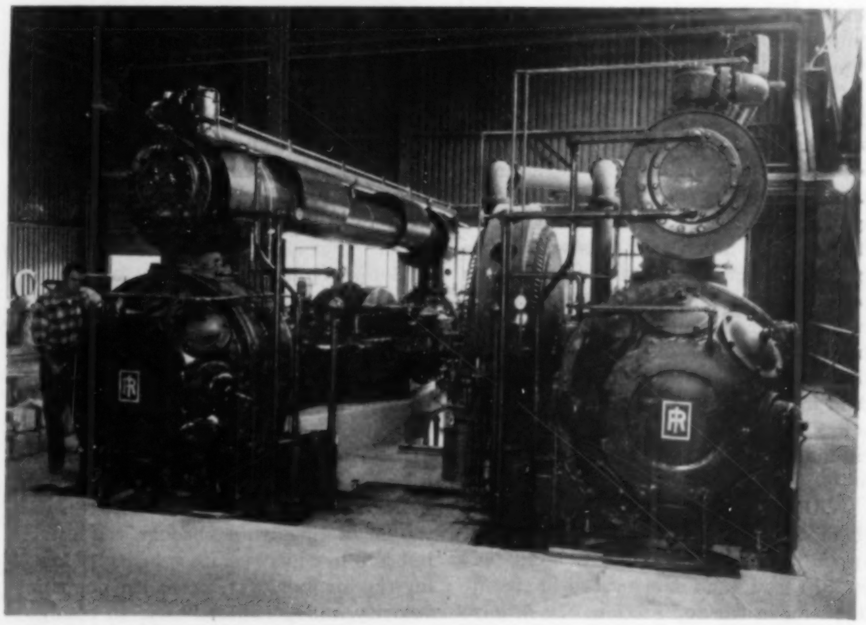
Shown at close range, left, is one of the Wheeler grinding mills. The insulated pipe connection at the bottom is the compressed-air inlet. The finely ground talc from the mill is carried upward through a pipe to cyclone collectors mounted above it. At the left of the mill is one of the bins that receive ground talc from the collectors and discharge it into spiral conveyors for transportation to storage bins. The diagram shows how the mill operates. Ore entering through a venturi-type feeder is entrained in blasts of compressed air (indicated by arrows) that issue from nozzles in the reduction chamber. The resultant violent agitation of the talc causes it literally to pulverize itself through attrition. The particles are then carried up and around the top of the passage, centrifugal force throwing the larger and heavier ones toward the outside edge and on downward to make another circuit. As the particles become smaller the centrifugal force has less effect on them and they work their way inward. When they reach the inner edge, they are light enough to be withdrawn by the air discharge.

●

SOURCE OF AIR FOR GRINDING

An Ingersoll-Rand Class PRE compressor (below) furnishes operating air for the battery of Wheeler mills. A 4-corner model, it has two low-pressure cylinders on the near end and two smaller high-pressure cylinders on the far end The machine has a capacity of 7150 cfm. and discharges at a pressure of 150 psi. It is driven by a General Electric synchronous motor that receives 4160-volt current from the plant substation.





energy reduction" mill could reduce talc to micron and submicron sizes on a full production-line basis. If the claim were founded on fact, Vanderbilt reasoned, and if the process could be integrated with conventional talc-milling machinery, it would provide a talc fine enough to meet the most exacting requirements of paint manufacturers and other leading industrial consumers.

Once satisfied that the mill would work, Vanderbilt lost no time in acquiring a talc property at Balmat, N. Y., about 8 miles from Gouverneur and in the heart of New York State's famous talc-mining district. Construction was started there in August, 1947, and by July, following, a 600-foot vertical, concrete-lined shaft was near completion and the first ore had been hoisted. A month later the mill, with a capacity of 200 tons a day, received its finishing touches. The initial shipment of finely ground ore was made in September, 1948, just thirteen months after work began.

The construction program was carried out under the direction of the company's present operating staff consisting of R. S. McClellan, vice-president, John Bulger, mine superintendent, and J. A. Gustin, mill superintendent. Mr. McClellan made the original examination of the properties. The plant was built by James Stewart & Company, Inc., while the shaft was sunk by Underpinning & Foundation Company, Inc., both New York firms.

Key unit of the plant is a battery of Wheeler mills each of which is made up of three sections of cast alloy steel. Put together, the parts form a hollow casing of variable cross section similar to that of a wind tunnel. Assembled, a mill has an over-all height of around 8 feet. Its outstanding feature is that actual pulverization is effected not by mechanical means but by impact and attrition of the particles one against another in a stream of air. Because grinding is done by an "elastic" or expansible fluid—in this case compressed air—Wheeler calls the mill a "fluid energy reduction" mill.

A reduction chamber in the lower section of the mill has several nozzles placed at an angle to the path of the air in the mill. Compressed to a pressure of 150 psi. and heated, the air enters at the bottom and rushes through the jets at a speed in excess of 1600 feet a second—nearly 1100 miles an hour. Inside the mill it whirls round and round like a gigantic flywheel, maintaining velocities of 150 to 400 miles an hour.

Crushed talc ore enters the mill near the bottom through a venturi-injection system. Picked up by the air blasts issuing from the nozzles it is set in violent motion. At the same time, talc particles already circulating in the mill pass through the reduction chamber at high speed. Under the furious agitation of the jets of air, the fast-moving particles bombard one another with machine-gun rapidity—break one another to bits.

Leaving the reduction chamber, the particles flash upward and around at velocities ranging from 200 to 600 feet a second. Although there is never more than a few pounds of talc in the mill, the speed at which the particles travel is so high that as much as 6 tons will pass a given point in one minute. Each time a particle moves through the chamber it gets smaller, and it may have to make 1500 to 2500 round trips before it reaches the proper size. Most of the grinding is done in the reduction chamber, but some is due to attrition of particles as the talc circulates through the remainder of the mill.

Withdrawal of the finished product is effected in a unique manner. As the mill operates, air is continually being expelled through an exit located in the inside wall in the top section. Each particle passing by this exit is subjected to two forces: (1) an inertia force attributable to its kinetic energy which tends to keep it on its course, and (2) the drag of the departing air which tries to divert it from its path and take it from the mill. Inertia acts on the mass of the particle; drag acts on its surface area. As the particle becomes smaller and its mass decreases, the inertia force naturally gets smaller. The drag also decreases but not as fast as does the inertia force. When the drag of the air issuing from the outlet overcomes the energy force of the moving particle, the bit of talc, ground to size, leaves the mill. Other larger and heavier particles, having more kinetic energy, do not succumb to the drag of the departing air and continue to recirculate in the mill until they have been reduced to proper size.

After leaving the mill and being separated from the air that carries it, the ground talc is gathered by two spiral conveyors which carry it to a cross-collecting spiral conveyor. Delivered to a Fuller-Kinyon pump, it is then sent through a pipe line to four finished-product bins or "silos" of 400-tons capacity each.

Before compressed air is fed to the Wheeler mills it is heated to give it greater velocity. Increasing the pressure of the air to make it go faster through the nozzle will work only up to a certain point, which engineers call the acoustic velocity; that is, when the speed of the air equals the speed at which sound will travel in that air. Beyond that point an increase in pressure will increase the total weight of air flowing through the nozzle but will not increase its velocity. Heating the air, however, raises the acoustic velocity and permits the air to emerge from the nozzle at higher speed.

All the air needed to operate the battery of mills is furnished by an Ingersoll-Rand PRE 2-stage, 4-corner compressor with a capacity of 7150 cfm. at 150 psi. discharge pressure. An efficient filter system on the intake makes sure that no stray talc dust or other foreign matter will get into the compressor cylinders. Incoming air first goes through a dry-type separator made of American Air Filter Company's Airmat filter paper. Any dust or other material still remaining in the air is then removed by passing it through two oil-bath-type filters (American Air Filter Company Cycoils) housed on the roof of the plant.

"How do you measure a particle for correct size when you can't even see it" is a question often asked by visitors. In

answer, company officials lead the way to the plant's laboratory and point to what is known as the Fisher Sub Sieve Sizer. A measured amount of ground talc, compressed by hand into a small section of tubing, is placed in the instrument and a stream of compressed air forced through it. A column of water, whose height is controlled by the rate at which the air passes through the sample, indicates in microns on a chart the average diameter of the particles.

Other instruments in the laboratory reveal additional facts about ground talc. One measures the viscosity of paint samples made with the talc. Another indicates the power of talc to reflect light. NYTAL usually has 87-95 percent reflectivity; that is, that much of the light falling on it is reflected back to the measuring device. Still another shows how much oil is needed to wet down a certain amount of each grade of talc, something a paint manufacturer must know to mix paints. These and certain chemical tests are made on hourly samples of the mill output, as well as on specimens taken at the mine both before and after the ore is produced.

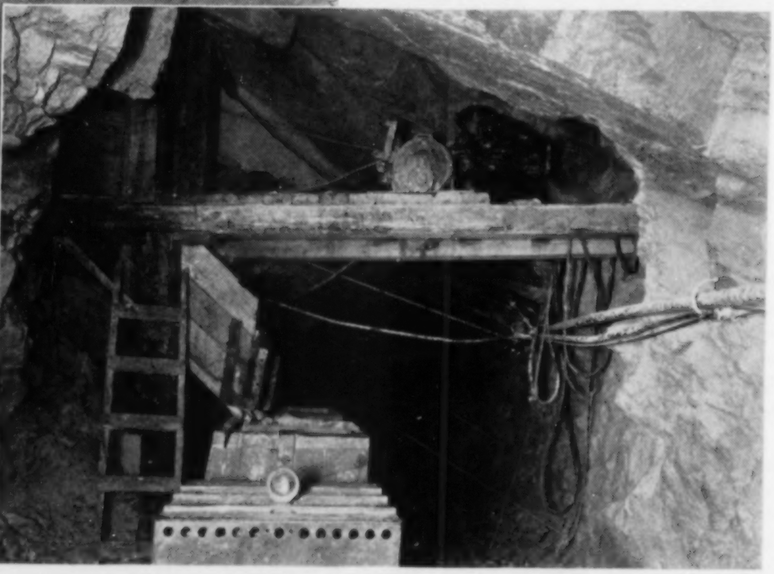
For manufacturers who do not require talc ground extremely fine, the company puts out NYTAL 100 and 200 which are not measured in microns. They are made in the ordinary manner by grinding the crushed and dried ore in a 10-foot by 66-inch Hardinge pebble mill. After classification in a Raymond Whizzer air separator working in a closed circuit with the mill, the material is screened to eliminate any foreign matter introduced accidentally and is pumped to the finished-product bins.

Both the output of the Wheeler mills and of the Hardinge is shipped from the plant in self-sealing paper bags. The talc is drawn as needed from separate storage silos by a Fuller-Kinyon rail-mounted pump with a capacity of 30 tons per hour. Sent to a St. Regis Paper Company automatic packaging machine, it is packed 50 pounds to a bag which, when filled, falls onto a conveyor that carries it to a waiting boxcar. Occasionally a boxcar is lined with paper and loaded with bulk material.

Three deposits on the Gouverneur Talc property form its present and future sources of ore. They occur in the form of parallel veins varying from 15 to 80 feet in thickness and dipping at approximately 45 degrees. Two of them outcrop on the surface. One of these, the American Vein, had been worked before the company acquired the land. The largest of the ore bodies does not outcrop. Oddly enough it was found by miners of the St. Joseph Lead Company. While looking for new deposits of zinc ore in their nearby Balmat Mine, they ran into the underground body of talc. At Vanderbilt's request, St. Joseph Lead mined a 90-ton "sample" from different parts of the vein and sent it to Wheeler's laboratories in Philadelphia for grinding tests. Vanderbilt then secured the rights to the hidden or main ore body as well as to the two outcropping ones. So far, most of the production has come from the American Vein, but in future the main ore body will be the principal source of supply. Development work was started in July, 1948, and mining shortly thereafter. Present output is about 200 tons a day, with two shifts working.

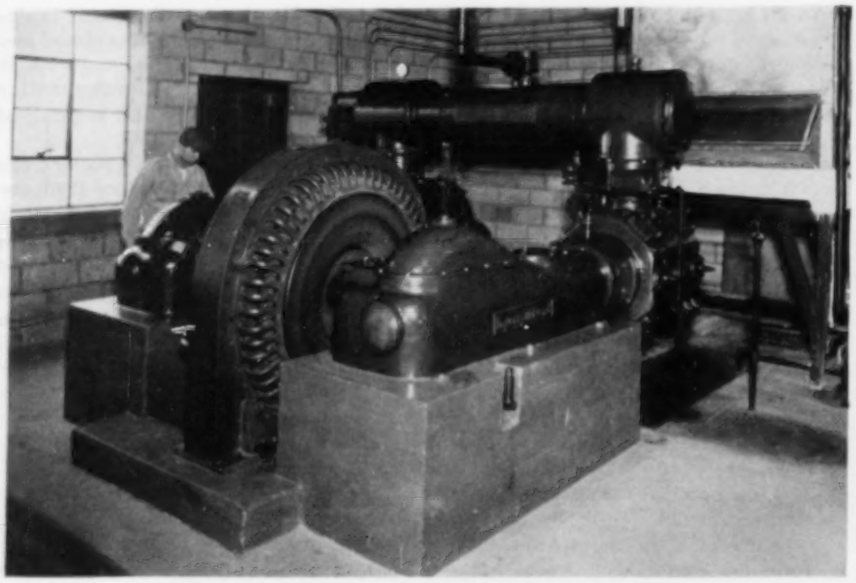
When Gouverneur Talc moved onto the property the old workings in the American Vein consisted of an inclined shaft and eight levels, all of which were flooded. Company officials hit upon a novel means of unwatering them, as follows: On the 300-foot level of the 600-foot vertical shaft that was sunk some distance from the old inclined one, they installed an air jet with a discharge pipe leading to the surface. Then they drove a tunnel from that level toward the old workings. When within some 40 feet of them, they pierced a hole through the remaining barrier with a diamond drill. When water began to flow into the pipe system in the new shaft the air jet was turned on, causing the water to rush up the discharge pipe to the surface. When its level had dropped to about the 150-foot mark, unwatering was finished by pumps located on the 300 level.

Each of the two levels of the new shaft—the 300 and the 500—has a loading



MINING THE TALC

Using a modified room-and-pillar method, rooms are mined out of the dipping veins, leaving enough ore between them as pillars to support the roof. Drilling in the ore and the enclosing rock is done with Ingersoll-Rand JB-4 Jackhamers equipped with 1½-inch standard steel Jackbits. Shown at the top-left are two drill runners driving a development heading with Jackhamers mounted on Jacklegs. The man at the left is utilizing a plank rest in putting in bottom holes. All holes are driven to a depth of 6 feet with single lengths of steel. In the central illustration a miner is drilling block holes for blasting large chunks of ore so that they will pass through the openings in the grizzly and fall into a loading pocket underneath. In the background is an I-R 2-drum, 7½-hp. slusher hoist that furnishes power for scraping ore to the grizzly. The bottom view shows a miner operating another I-R hoist mounted on a platform above a haulageway. It slushes broken ore from a stope to a chute that loads it into mine cars.



MINE AIR COMPRESSOR

Air for operating rock drills, slusher hoists, etc., in the mine comes from this Ingersoll-Rand Type XRE compressor. A 2-stage machine having a capacity of 1000 cfm., it discharges at 110 psi. and is driven by a General Electric 200-hp. synchronous motor. The air is stored in a receiver and is carried down the shaft into the working areas by a 6-inch pipe line.

pocket with a capacity of 125 tons. Ore is dumped from mine cars onto a grating, with 10-inch openings, located above each loading pocket. From there it goes into a 3-ton measuring pocket and then into a 3-ton self-dumping skip which raises it to a 25-ton bin in the headframe. From there, after being reduced to 1-inch size in a 3-foot-diameter Traylor gyratory primary crusher, it is carried by a 20-inch conveyor belt to three 100-ton wet-ore storage bins in the milling plant.

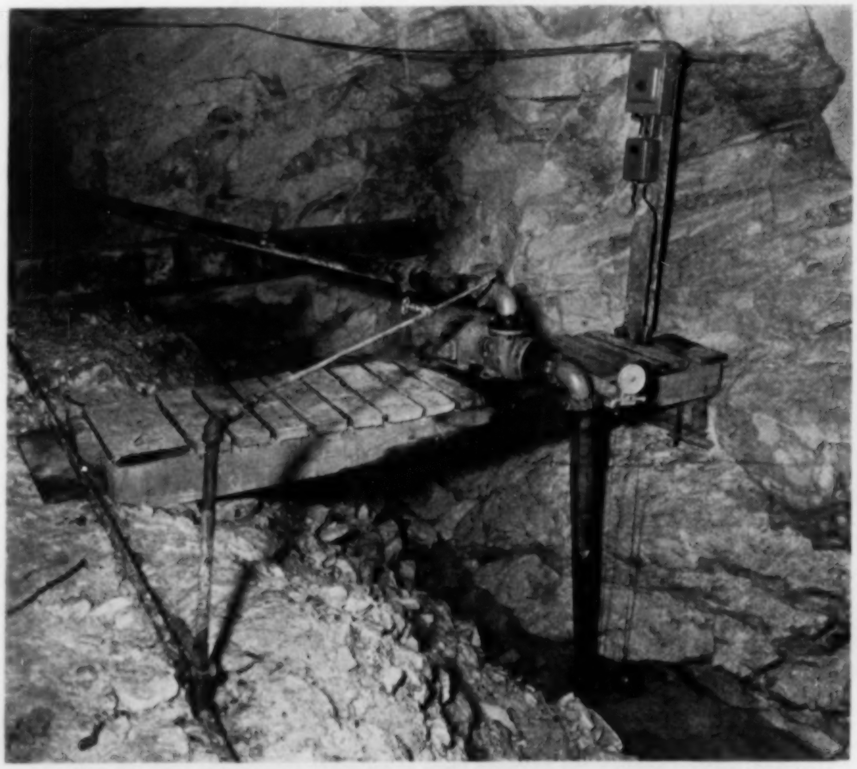
Ore is drawn as needed from the wet-ore storage bins for crushing and screening. Undersize is put through an oil-burning Ruggles-Coles drier, a huge rotating cylinder 5 feet in diameter and 30 feet long, before it is crushed in a Symons short-head cone crusher and delivered by means of bucket elevators and spiral conveyors to four 400-ton dry-ore storage bins or silos. From the latter the material is withdrawn—frequently from several at once for blending purposes—by vibrating feeders and goes by spiral conveyors and bucket elevators to a dry-ore surge bin. Some of the ore removed from this bin travels in spiral conveyors to individual feed bins which serve the Wheeler mills. The remainder is sent by way of a 5-ton-capacity feed bin and a constant-weight feeder to the Hardinge pebble mill.

Most of Gouverneur Talc's production has, up to date, been used by paint and ceramic manufacturers east of the Mississippi River as a filler and extender in oil-base paints (principally white outside paints), as a pigment for cold-water paints, and in the making of ceramic whiteware such as semivitreous tableware, electrical porcelain, high-frequency insulators, and glazed wall tile.

In both these industries, particle size and shape, uniformity of chemical composition, and color are of the utmost importance. The ceramic industry is primarily concerned with these factors from the standpoint of product control—to be sure the things turned out will have the physical qualities to do the jobs for which they are intended. In the case of the paint manufacturer, particle size and shape greatly influence hiding power, spreading power, and oil absorption of the finished paints.

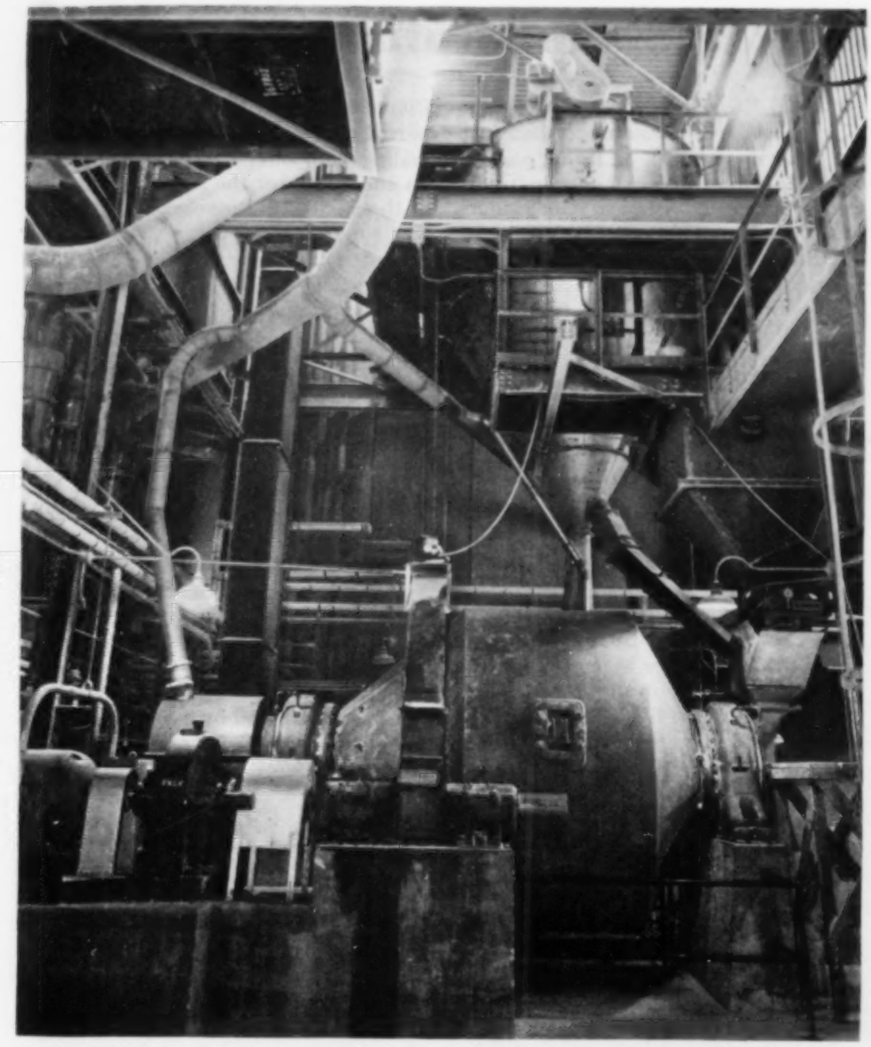
The extreme whiteness of the talc mined in the Gouverneur district insures paints with excellent hiding power, and the fineness of the particles produced by the air-powered mills gives better texture. Further, because they are round instead of angular they are less prone to agglomerate which, together with their smallness, largely prevents settling so common in mixed paints, something that anyone who has stirred the sludge in the bottom of a can of paint can well appreciate.

Fine grinding is becoming increasingly important to industry in general. Only a few years ago, 325-mesh or 44-micron size was thought to be very fine. Today, some industries consider particles averaging 3 to 5 microns to be medium



DRAINING THE MINE

Installed on the 300 level is this Ingersoll-Rand 1½-hp. Motorpump with a capacity of 150 gpm. under a head of 28 feet for removing water that drains from a nearby stope. Fitted with a ball-float control that starts and stops the motor with changes in water level, it automatically transfers water to a sump from which it is lifted to the surface by another I-R Motorpump with a capacity of 250 gpm. under a head of 400 feet. A third, large-size Motorpump on the 500 level delivers water from a sump located there to the one on the 300 level. A standby unit with a capacity of 240 gpm. at 700 feet of head is stationed on the 500 level to lift water to the surface should the other pumps fail to operate.



HARDINGE PEBBLE MILL

This is the mill that grinds talc to above-micron sizes. The Raymond air separator above it divides fine from oversize talc and chutes it to a bin. The oversize is returned to the mill for further grinding.

ground. Others are asking for sizes as small as 0.1 micron. One reason for this is that chemists and engineers have found that fine grinding gives many materials new properties or greatly changes their existing properties. For instance, the rate of chemical reaction between solids and liquids or gases is speeded up remarkably when the solid is finely ground because its exposed surface area is greater than it would otherwise be. If you reduce one cubic foot of material (6 square feet of surface area) to 0.5-micron size you will end up with a surface area of more than 80 acres. This principle is applied in our modern catalytic-cracking process used by petroleum and gas industries.

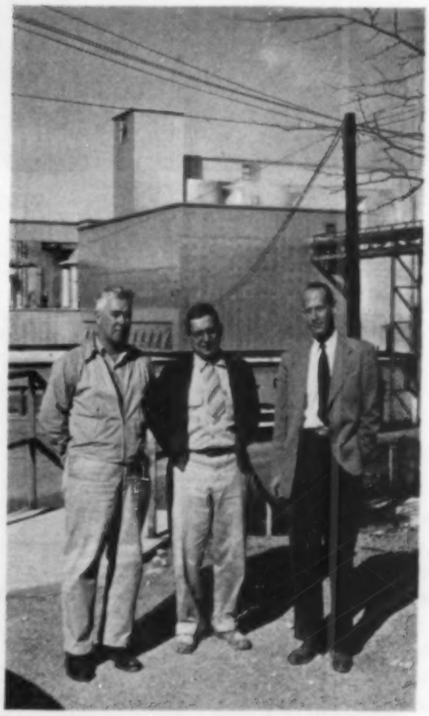
The air-powered units can do more to industrial materials than just reduce their size. Because the atmosphere in the mill can be controlled, conditions inside the mill can be altered to suit the nature of the material being processed. Thus many chemical and physical changes can be brought about during grinding. A chemical reaction can be established or one prevented from taking place. Metal oxides can be reduced to metal, or the metals oxidized; one substance can be coated with another, either solid or liquid; and materials can be dehydrated, as well as mixed and blended.

Grinding of foodstuffs such as cereal grains, peas, beans, etc., results in an end product with unusual keeping qualities. For instance, about seven years ago some fresh peas were ground in a fluid-energy mill. The resultant powder has been kept in a friction-top container since then, with no special attempt to maintain a tight seal or to preserve the contents in any way. Mixed with water, it tastes and smells like fresh peas. Even the original green color remains.

By using refrigerated air in the Wheeler mill it is possible to reduce substances with low melting points to powder form—substances that cannot easily be ground by mechanical means. Cocoa nibs, containing 53 percent cocoa butter and melting at about 81°F., will melt if rubbed between the fingers. By the use of refrigerated air, and by taking advantage of the slight cooling effect of the air as it expands upon issuing from the nozzles in the reduction chamber, the nibs can be ground exceedingly fine. The cooling effect of the air more than offsets any heat induced by friction as the particles impinge against the walls of the mill. The same thing applies to other low-melting-point materials such as fatty acids, glycerides, and cocoanut meat.

More than 1000 different substances have been ground in the Wheeler mill. These include insecticides and fungicides, cork, wood, herbs for medicinal purposes, grains, vegetable and food products, minerals as hard as corundum, iron ore, metals such as aluminum, cast iron, and lead, and many others. In fact, the list is so long that the problem resolves itself into eliminating the few not suitable for grinding in the mill.

Gouverneur Talc Company has the largest installation of the new mills in the country. Other plants are successfully grinding paint pigments, insecticides, and other materials. The results accomplished by the method, as proved by the mills in service, indicate that more and more industries will in future toss their fine-grinding problems into a stream of air and let them knock themselves to bits—very tiny bits, indeed.

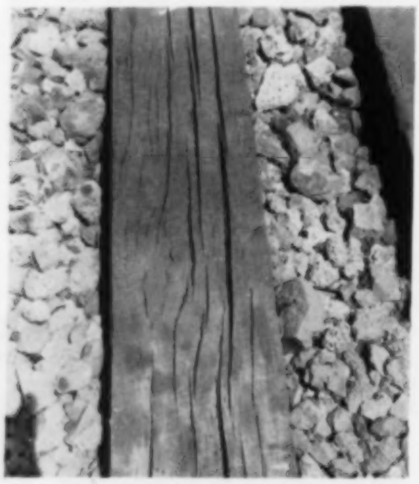


OPERATING PERSONNEL

Here are the men responsible for the construction of the new plant and for its operation. Left to right: John Bulger, mine superintendent; J. A. Gustin, mill superintendent; and R. S. McClellan, vice-president and general manager.

Roofs for Railroad Ties

Operators calk large checks and splits in ties before spraying on the sealing compound.



After ten years of service this creosoted main-line tie shows severe checking and splitting.

Badly damaged tie coated with the sealing compound to retard further checking and decay.

A RAILROAD tie lying in its bed of ballast has to bear more than just the pounding weight of trains passing over it. Water, plants, and minute organisms cause it to decay. Hot cinders from coal-burning locomotives scorch it. Weathering causes it to check and split. Eventually it must be removed.

The Erie Railroad used to get approximately ten years of service from a sleeper before rot and mechanical failure forced its replacement. In 1914 the road started the practice of applying creosote under pressure to its ties to make them more resistant to decay. This treatment lengthened their average life to 23 years. Since then the chief causes of renewal have been mechanical wear and splits.

A sleeper develops checks and splits because its top half is exposed to different climatic conditions than its bottom half. Ballast usually keeps the lower face and sides somewhat moist. The upper surface, on the other hand, is alternately drenched by rain, swept by wind, or baked by the sun. It shrinks and swells under these changes, while the bottom remains about the same in size. This sets up severe stresses that lead to checking of the top face. Later, these checks become splits which, through the wedging action of dirt and ice, extend progressively deeper into the tie, exposing to decay wood that has not been creosoted.

B. Blowers, chief engineer of maintenance of way of The Erie Railroad, conceived the idea that some sort of a "roof" on a sleeper would minimize the effect of checking caused by rain and sunshine. His plan was to apply a coating directly to the upper surface to enable it to resist the elements in the same manner as does a built-up roof. To give it the desired protection, a compound for that purpose would have to adhere to creosoted wood, remain sufficiently plastic under normal temperature changes to expand and contract with the wood, and heal itself if broken.

Blowers explained his idea to Koppers Company, which set its Technical Department to work on it. Twenty-two sealing compounds were developed in an effort to meet the requirements, and of these, No. 16 was selected as the one best suited for field testing. In October, 1947, the top face of every tie lying within a ½-mile section of the Erie's main-line track near Greenville, Pa., was covered with that material. It was applied by spraying by means of an Alemite pump operated with air under pressure supplied by a crawler-mounted compressor. A platform mounted on the back of the latter carried the pump and a drum of the compound, the unit moving along the tracks under its own power as the work progressed.

Compressed air for operating the spray equipment was supplied by this Ingersoll-Rand Crawl-Air compressor.

Operators used long-handled guns to spray the compound onto the ties. Shields laid over the rails prevented them from becoming spattered, and the men made a special effort to keep the ballast clean. Following application, the coating was spread by a soft brush to fill deep checks and splits and to make certain that the openings between the tie and the tie plates were sealed. It was not necessary to clean out checks and splits before spraying, air issuing from the nozzle being sufficient to blow away all dirt before the compound hit the tie.

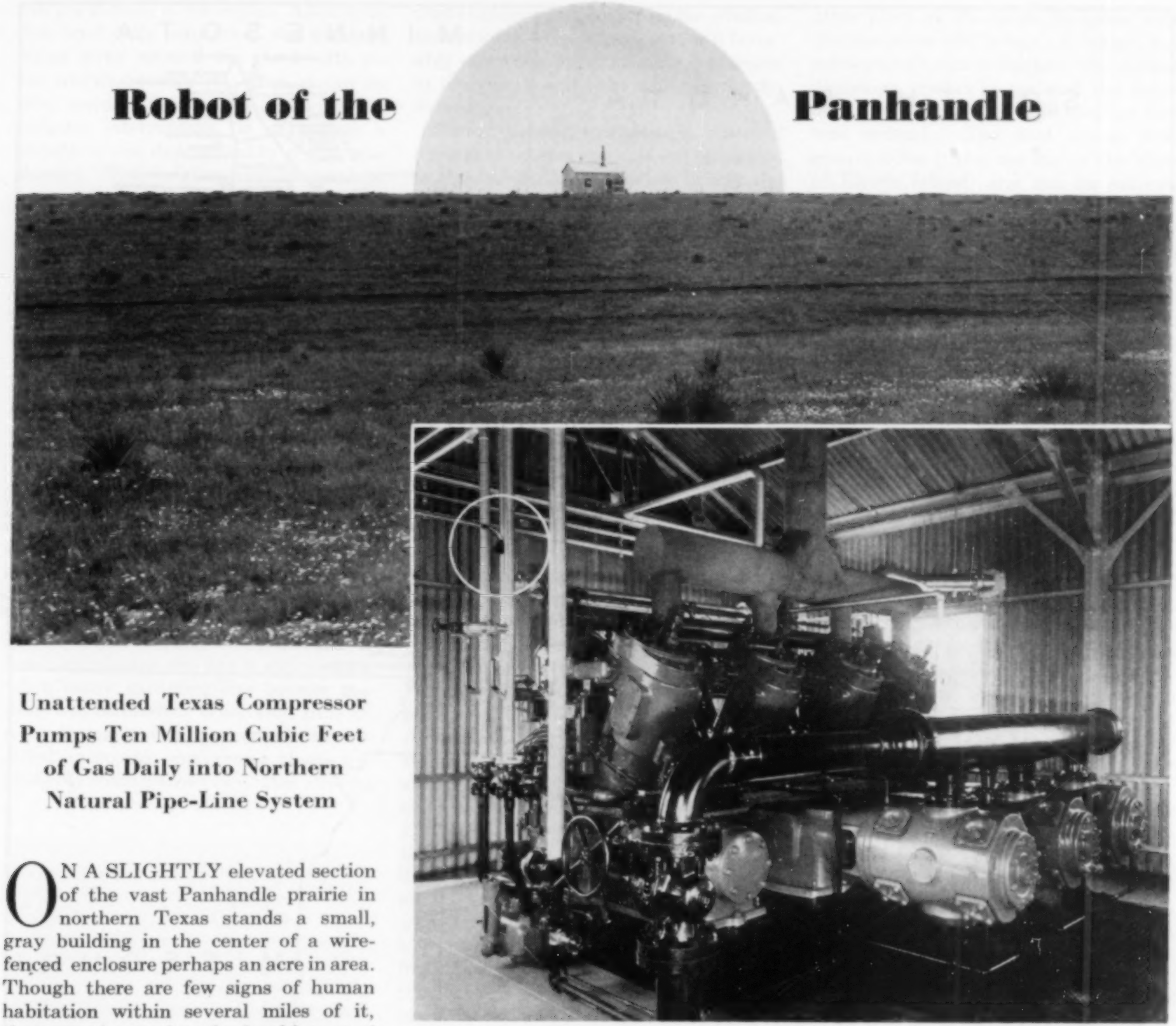
Erie's test section has remained in good condition for more than two years, and the coating has adhered to the creosoted wood. When first put on, it formed a tough outer film that stayed plastic throughout temperature changes ranging from zero to 96°F. Beneath the surface the compound remains pliable at any temperature, it is claimed. In addition to reducing checking and splitting, the coating is expected to help preserve the decay-resisting effect of creosote by retarding evaporation of its lighter, more volatile fractions.

Future plans of The Erie Railroad call for experiments in which the area under the tie plates also will be similarly protected before the plates are installed. This will keep the area dry and exclude abrasive material through which the cutting action of the plates on the tie is aggravated. In this test the coated ties will be covered with fine gravel to prevent exposure of the compound to the weather and to shield it and the tie from hot cinders.

Although not enough time has elapsed to properly evaluate the results, it is believed that the lengthened service life of the treated ties well justifies the expense involved. According to Mr. Blowers, if each one lasts two or three years longer than it now does, that will more than pay for the cost of "roofing."

Condensed from an article appearing in the December, 1949, issue of "Modern Railroads."

Robot of the Panhandle



"ON THE LONE PRAIRIE"

The Burnett compressor station (top) in the expansive Texas Panhandle region is several miles off a main highway and is normally visited only once a day. Nevertheless, the Ingersoll-Rand Type XVG gas-engine-driven unit that it houses (above) runs continuously, boosting the pressure of gas drawn from ten wells in the general area and starting it on its way northward through the transmission system of the Northern Natural Gas Company. Mechanical safety devices will shut the compressor down instantly if something goes wrong. From a telephone transmitter (in white circle) hanging near the power cylinders, a circuit extends 6 miles to the Skellytown main-line pumping plant, where an employee listens in on a receiver every half hour for the sound of the running machine. If, as rarely happens, the line is silent, someone is sent to the Burnett station to determine the cause of the trouble and to restart the compressor.

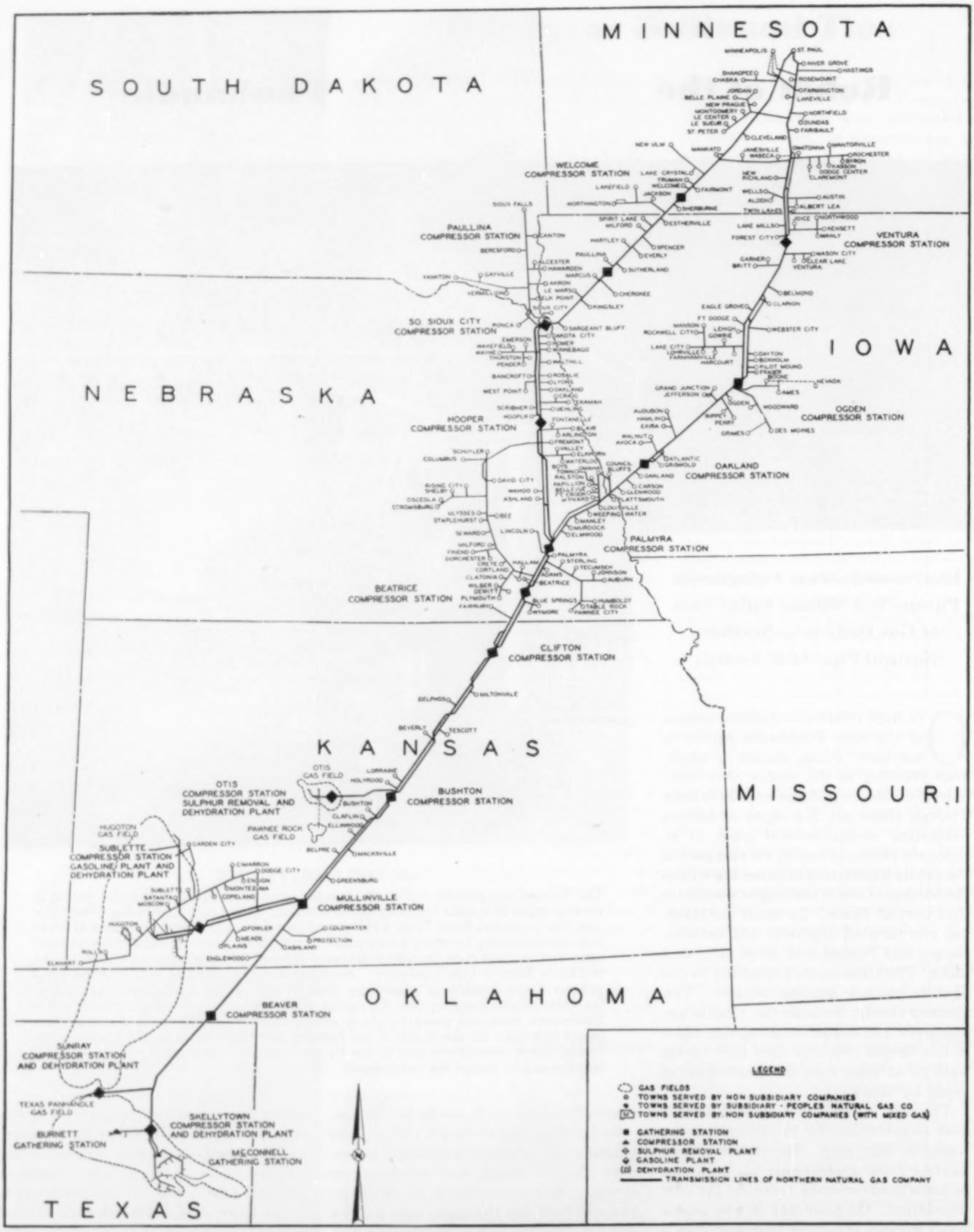
Unattended Texas Compressor Pumps Ten Million Cubic Feet of Gas Daily into Northern Natural Pipe-Line System

ON A SLIGHTLY elevated section of the vast Panhandle prairie in northern Texas stands a small, gray building in the center of a wire-fenced enclosure perhaps an acre in area. Though there are few signs of human habitation within several miles of it, there are plenty of cattle, for this part of the gently undulating expanse lies within the borders of one of the largest ranches in that part of Texas. To reach the building you turn off Highway 152 between Borger and Pampa and drive for 3 or 4 miles. The chances are a hundred to one against meeting another vehicle. You proceed slowly, because the road is unimproved and has its rough spots, and if it has rained recently you had better walk or at least take the precaution of going by truck.

The road is destined to remain poor or even to get worse, for the tenant farmer wants it that way. He says it deters hunters from overrunning his land and perhaps inadvertently reducing the cow population. On your way in you pass a small wooden structure that was once a school but is now abandoned. Occasionally you see a pipe extending above ground, and usually there is a fence around it. These pipes are outlets of natural-gas wells, for this area is within the fabulous Texas Panhandle gas and oil field. Each well is connected to an underground network of piping that takes off the gas so it can be put to use.

So far as appearances go, the solitary building on the rise of land might be unused, for its doors and windows are closed. As you approach it, however, you can hear the rhythmic exhaust of a gas engine. Any experienced oil or gas-field man could have told you that such a machine was inside because he would have noted the characteristic exhaust pipe protruding from the roof and encased by a silencer. Within the transite-sided structure is an Ingersoll-Rand Type XVG, 300-hp., gas-engine-driven compressor. It takes in gas from various feeder lines connected to gas wells in the surrounding area, increases its pressure, and transmits it 6 miles to a main-line compressor station of the Northern Natural Gas Company at Skellytown. From there it starts northward toward points of consumption that may be as far away as St. Paul or Minneapolis, Minn.

The unusual thing about the outpost compressor plant is that it is almost wholly unattended. Each morning someone from the Skellytown station visits it to check the cooling water and the lubricating oil and to change the chart in the instrument that records the volume of


MINNESOTA
SOUTH DAKOTA
NEBRASKA
IOWA
KANSAS
MISSOURI
OKLAHOMA
TEXAS
MINNEAPOLIS
ST PAUL
WELCOME COMPRESSOR STATION
PAULLINA COMPRESSOR STATION
VENTURA COMPRESSOR STATION
SO. SIOUX CITY COMPRESSOR STATION
OGDEN COMPRESSOR STATION
HOOPER COMPRESSOR STATION
OAKLAND COMPRESSOR STATION
PALMYRA COMPRESSOR STATION
BEATRICE COMPRESSOR STATION
CLIFTON COMPRESSOR STATION
OTIS GAS FIELD
OTIS COMPRESSOR STATION SULPHUR REMOVAL AND DEHYDRATION PLANT
BUSHTON COMPRESSOR STATION
PAWNEE ROCK GAS FIELD
HUGOTON GAS FIELD
SUBLETTE COMPRESSOR STATION GASOLINE PLANT AND DEHYDRATION PLANT
MULLINVILLE COMPRESSOR STATION
BEAVER COMPRESSOR STATION
SUNRAY COMPRESSOR STATION AND DEHYDRATION PLANT
TEXAS PANHANDLE GAS FIELD
SKELLYTOWN COMPRESSOR STATION AND DEHYDRATION PLANT
BURNETT GATHERING STATION
McCONNELL GATHERING STATION
LEGEND
GAS FIELDS
TOWNS SERVED BY NON SUBSIDIARY COMPANIES
TOWNS SERVED BY SUBSIDIARY - PEOPLES NATURAL GAS CO
TOWNS SERVED BY NON SUBSIDIARY COMPANIES (WITH MIXED GAS)
GATHERING STATION
COMPRESSOR STATION
SULPHUR REMOVAL PLANT
GASOLINE PLANT
DEHYDRATION PLANT
TRANSMISSION LINES OF NORTHERN NATURAL GAS COMPANY

DISTRIBUTION SYSTEM OF NORTHERN NATURAL GAS COMPANY

The main line runs northward from Skellytown, Tex., and forks near Lincoln, Neb., into two branches that extend to the St. Paul-Minneapolis area. It is made up of 1947 miles of pipe that ranges from 16 to 24 inches in diameter. Secondary delivery lines and gathering lines in the gas fields bring the length to more than 4000 miles. This includes the lines of a subsidiary, Peoples Natural Gas Company, which operates in certain communities in Nebraska, Kansas, Iowa, and Minnesota. The gas leaves Texas under 500 psi. pressure and reaches 750 psi. between Sioux City, Iowa, and Minnesota. Sixteen booster stations spaced along the main line house 139,310 horsepower of compressors, and additional machines on gathering lines total 5230 hp. The locations of the Burnett and McConnell gathering-line stations, with which the accompanying article is chiefly concerned, are shown at the lower left.

fuel gas burned in the engine. Aside from this brief daily inspection, the machine chugs away around the clock with no one anywhere near it. That it can do this, month after month and virtually without interruption, is of course a tribute to the dependability of the machinery. The building and its contents represent an investment of approximately $50,000. While this is not a tremendous sum in terms of modern industry equipment financing, it is certainly large enough to warrant protection. It is significant that the plant's safeguards are entirely mechanical and that they are considered sufficiently trustworthy to permit doing away with human supervision.

For the present, the little station is not highly important in the operation of the Northern Natural Gas Company system—it feeds into the main line only a small fraction of the total gas supply. It is, however, a symbol of things to come and marks the beginning of a trend. In the Panhandle, as well as in other Southwest fields from which heavy and rapidly increasing volumes of gas are being withdrawn, the day is approaching when many gathering-line booster stations will be needed. When that time arrives, scores or even hundreds of these so-called automatic compressor plants will probably come into service. It is obvious that economy resulting from the elimination of labor-attendance costs will favorably affect the price ultimate consumers in the North and East will pay for delivered gas.

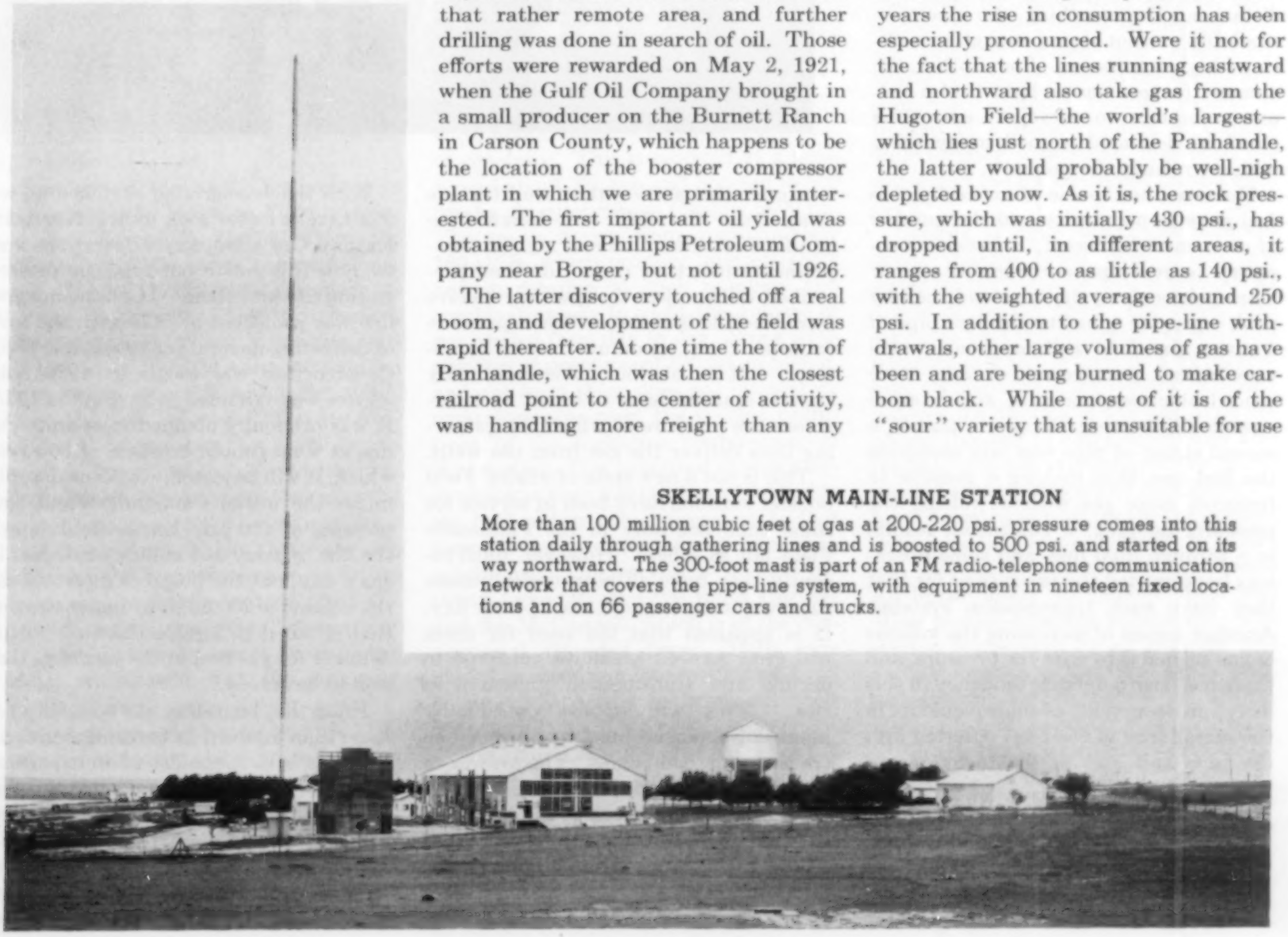
To explain why increasing numbers of these field booster stations will be needed in the future, let us review briefly the history of the Texas Panhandle. This enormous natural-gas and petroleum reservoir, which underlies all or parts of the counties in the tier north of Amarillo, was first tapped in 1919. Its discovery came about through field work done in 1908 by Charles H. Gould, then professor of geology at the University of Oklahoma. While investigating possible sources of water supply for the U. S. Reclamation Service, he noticed a geological structure that was favorable to the accumulation of oil or gas. This elongated anticline or dome of sedimentary strata rests on top of a buried granite mountain range, called the Amarillo Mountains, which extends southeastward into Oklahoma, where it rises to the surface as the Wichita Mountains.

The first test was begun in 1916 after M. C. Nobles, an oilman, had asked Professor Gould if he knew of a likely place to drill. A well put down for the Amarillo Oil Company on the Masterson Ranch, 28 miles north of Amarillo, struck a flow of 15,000,000 cubic feet of gas a day at a depth of 2605 feet on May 11, 1919. Gas was then of little value in that rather remote area, and further drilling was done in search of oil. Those efforts were rewarded on May 2, 1921, when the Gulf Oil Company brought in a small producer on the Burnett Ranch in Carson County, which happens to be the location of the booster compressor plant in which we are primarily interested. The first important oil yield was obtained by the Phillips Petroleum Company near Borger, but not until 1926.

The latter discovery touched off a real boom, and development of the field was rapid thereafter. At one time the town of Panhandle, which was then the closest railroad point to the center of activity, was handling more freight than any other place on the Santa Fe Lines, with the exception of Chicago. A branch was subsequently run to Borger. The drilling campaign gradually outlined the limits of the productive area, and they are now well defined. The field covers 2180 square miles (twice the size of the State of Rhode Island) and has an extreme length of 120 miles.

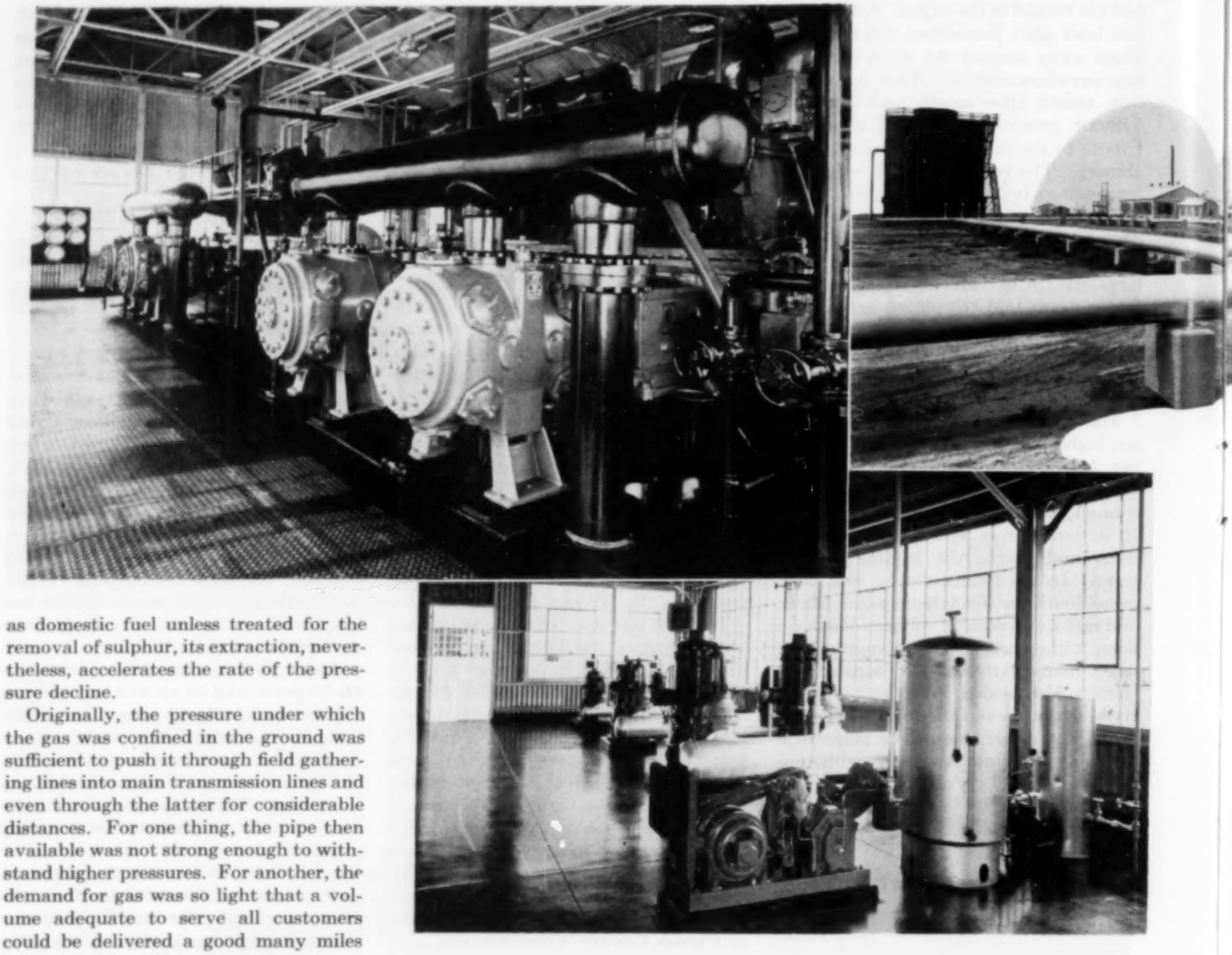
Gas was first piped from the field in 1920 to supply Amarillo. In 1926 a line was laid to Wichita Falls and other nearby Texas communities. A year later, Lubbock, Plainview, Midland, and 39 other towns in the Panhandle were given service and a separate line was run to Fort Worth and Dallas. Gas was first exported from the state in 1928 when three lines were built northward and eastward to serve areas around Denver, Colo., Wichita, Kans., and Kansas City, Mo. The last-mentioned artery was afterwards extended to Detroit, Mich. In 1930-31 were launched two more interstate systems, with their terminals at Chicago, Ill., and Minneapolis, Minn. Within the past three years a second line has been laid to Denver and one has reached Los Angeles, Calif.

Some gas has, then, been withdrawn for 30 years, and for around two decades extraction has been heavy, especially since all the interstate lines have been continually increased in carrying capacity and extended to serve additional sections. During the past four or five years the rise in consumption has been especially pronounced. Were it not for the fact that the lines running eastward and northward also take gas from the Hugoton Field—the world's largest—which lies just north of the Panhandle, the latter would probably be well-nigh depleted by now. As it is, the rock pressure, which was initially 430 psi., has dropped until, in different areas, it ranges from 400 to as little as 140 psi., with the weighted average around 250 psi. In addition to the pipe-line withdrawals, other large volumes of gas have been and are being burned to make carbon black. While most of it is of the "sour" variety that is unsuitable for use



SKELLYTOWN MAIN-LINE STATION

More than 100 million cubic feet of gas at 200-220 psi. pressure comes into this station daily through gathering lines and is boosted to 500 psi. and started on its way northward. The 300-foot mast is part of an FM radio-telephone communication network that covers the pipe-line system, with equipment in nineteen fixed locations and on 66 passenger cars and trucks.



as domestic fuel unless treated for the removal of sulphur, its extraction, nevertheless, accelerates the rate of the pressure decline.

Originally, the pressure under which the gas was confined in the ground was sufficient to push it through field gathering lines into main transmission lines and even through the latter for considerable distances. For one thing, the pipe then available was not strong enough to withstand higher pressures. For another, the demand for gas was so light that a volume adequate to serve all customers could be delivered a good many miles without raising the pressure.

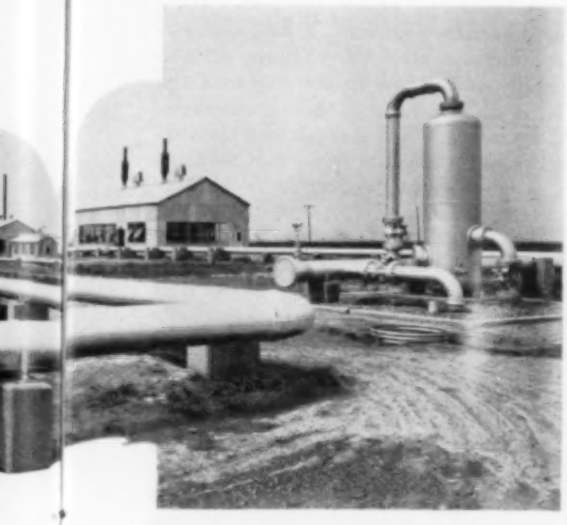
However, as the use of natural gas as fuel grew in popularity and the number of consumers increased, it became necessary to recompress the gas at one or more points along the lines and thereby push a greater quantity through pipe of a given size. As still more customers were added, compressor stations were spaced at closer intervals, and in some stretches lines were "looped"; that is, a second string of pipe was laid alongside the first one, thus making it possible to transmit more gas without raising the pressure. Looping, if continued, results in a through dual line, and some operators have carried the practice so far that they have such transmission systems. Another means of increasing the volume of gas carried is to raise the pressure, and there has been a definite tendency in this direction as a result of improvements in the metallurgy of the steel entering into the pipe and also in the technique of making pipe.

Thus, while there has been a steady trend towards higher main-line transmission pressures, the field pressure—as we have seen—has been gradually declining. Because the compressors in the first main-line station that send the gas away from the field are designed to handle a certain volume at a given compression ratio, they cannot do their prescribed work unless the gas they receive from the field is under sufficient pressure to meet their minimum intake conditions. It is obvious, therefore, why booster stations have to be set up to increase the pressure at which the gathering lines deliver the gas from the wells.

This is not a new state of affairs. Field booster stations have been in service for some time not only in the Panhandle Field but in others. However, until recently they have all been under human supervision throughout the 24-hour day. It is apparent that the need for them will grow as well pressures continue to decline and transmission pressures to rise. This will impose continually mounting financial burdens on pipe-line transmission companies. The answer to the question as to how to keep operating costs at a minimum seems to be the unmanned, automatic station. For that reason the isolated little building on the Burnett Ranch is of more than ordinary interest to gasmen right now.

With this background sketched in, we will take a closer look at the Northern Natural Gas Company's operations and see how this new robot-type compressor station fits into them. The transmission line was projected in 1929 with the idea of delivering natural gas to Omaha, Neb. Construction was begun in 1930, and service was extended to St. Paul in 1933. It was originally planned to operate the line at a maximum pressure of 350 psi., which, it will be noted, was considerably under the initial Panhandle Field well pressure of 430 psi. Engineers designed the line to carry 215 million cubic feet of gas a day, but the board of directors cut the volume to 200 million, demonstrating that it failed to foresee the huge future demand for gas fuel in the territory that was to be served.

From that beginning the company has more than doubled its transmission facilities and is in the midst of an expansion program that will continue through 1951. Between 1945 and the end of 1948 expenditures of more than $40,000,000 for pipe lines, compressor stations, gas wells, etc., increased the system capacity from 243 million to 425 million cubic feet



McCONNELL GATHERING-LINE COMPRESSOR STATION

This station pumps an average of 40 million cubic feet of gas daily to the Skellytown main-line transmission station, taking it in at around 110 psi. pressure and discharging it at 235 psi. In the general view at the left, gas from wells in the area comes in at the extreme right, passes through the cylindrical cleaner to remove condensate, rust, scale, etc., picked up in the pipes, and then goes to the compressors in the central building. Beyond the latter is the measuring station and, next, the auxiliaries building. At the left is a Fluor induced-draft cooling tower over which water is pumped at the rate of 125 gpm. to cool the compressor circulating water and lubricating oil and also to remove the heat of compression from the outgoing gas. The latter is carried in the pipe in the foreground, which goes underground as soon as it leaves the premises. The view at the extreme left shows two Ingersoll-Rand Type KVG 800-hp., single-stage, gas-engine-driven compressors. Below is a picture of the interior of the auxiliaries building. In the foreground is a Type 30 compressor that furnishes air at 250 psi. pressure for starting the KVG units. On its right is the zeolite equipment that softens the water used to cool the main compressors. In the background are duplicate pumps for cooling-tower service. Taking suction from reservoirs beneath the floor, one pumps raw water over the tower, another circulates cooling water through coils in the tower and from there to the compressors, and a third handles lubricating oil.

per day. Last year's construction budget carried $13,845,000 to bring the load to 470 million cubic feet. It is planned to spend an additional $52,000,000 in 1950 to reach a daily capacity of 600 million cubic feet.

As of January 1, 1949, the system was delivering gas directly and indirectly to 560,000 consumers in the states of Kansas, Nebraska, Iowa, South Dakota, and Minnesota. They were located in 222 towns and cities having a combined population of 2,054,000. Gas sales in 1948 aggregated 133.7 billion cubic feet, an increase of 23 billion over 1947. Of the total, 113.7 billion cubic feet was bought at town borders by 31 gas utilities for resale or consumption; 17.7 billion cubic feet was retailed direct to customers, mostly industries; and miscellaneous and field sales accounted for 2.3 billion cubic feet.

Northern draws about 60 percent of its gas from the Hugoton Field in Kansas and Texas, 31 percent from the Texas Panhandle, and the remainder from Pawnee Rock and Otis fields in Kansas. At the end of 1948 it controlled, through ownership or leaseholds, the gas rights on 274,929 acres of land on which there were 148 producing wells. Those sources accounted for approximately 17 percent of that year's gas supply. The remaining 83 percent was purchased under contracts that give the company access to production from 416,776 acres on which there are 488 wells. Available reserves to meet future needs were calculated on August 31, 1948, to aggregate 3680 billion cubic feet, or sufficient to last 21 years at the annual withdrawal rate the company expects to reach in 1951.

As an accompanying map shows, the main transmission line extends from Skellytown, Tex., to a point near Minneapolis, Minn. It divides near Lincoln, Neb., into two branches that diverge to the east and west and then come together again near Minneapolis. The main line consists (as of December 31, 1948) of 1947.1 miles of pipe, of which all but 96 miles is from 16 to 26 inches in diameter. Branch delivery lines have a combined length of 1499.5 miles and field gathering lines of 560.9 miles, making a total for the system of 4007.5 miles.

The pipe is designed for maximum working pressures ranging from 400 to 800 psi. in different parts of the system. Leaving Texas, the main line carries a pressure of 500 pounds. The highest present operating pressure is 750 psi. between Sioux City, Iowa, and Minneapolis. At the end of 1949, for maintaining pressures as service demands require, there were sixteen main-line compressor stations housing machines aggregating 139,310 hp. Five others, containing compressors with a combined capacity of 5230 hp., are on gathering lines. Of all the stations the one on the Burnett lease is the smallest.

The Skellytown Station normally transmits around 108,000,000 cubic feet of gas daily. This is received at a pressure of about 220 psi. and boosted to 500 psi. by six compressors totaling 6600 hp. The gas is drawn from approximately 160 wells, which produce intermittently and in rotation in such numbers and combinations as to yield the volume of gas needed from day to day. Some wells still flow at pressures of 220 psi. or higher, and gas from them does not necessitate compression to meet the suction conditions of the main-line compressors at that station. Gas produced at well pressures lower than 220 psi. is compressed in the field to bring its pressure up to that required by the Skellytown operating conditions. This service is divided between two stations—the robot Burnett and the McConnell, which is of the conventional attended type. Both were placed in operation late in 1948 and will be described briefly to bring out their differences.

McConnell Station, located about 5 miles south of Skellytown Station, delivers to the latter an average of 40,000,000 cubic feet of gas daily. This is drawn from low-pressure wells through gathering lines that feed into an 18-inch intake manifold. Coming into the compressors at around 110 psi., it is compressed to 235 psi. for transmission. On the way to Skellytown it passes through the Cargray natural-gasoline plant of Hagy, Harrington & Marsh, where gasoline, butane, and propane are extracted from it.

McConnell Station contains three Ingersoll-Rand Type KVG, single-stage, gas-engine-driven compressors—two of 800 hp. and one of 880 hp. Each has eight 15¼x18-inch V-type power cylinders and two 15x14-inch compression cylinders. They operate continuously and, in conformance with the best oil and gas-field practice, are adequately safeguarded against damage and stoppage. As the machines were designed and built for heavy-duty service, they seldom develop trouble so long as they are properly cooled and lubricated. Water circulated through the engine and compressor-cylinder cooling jackets is treated in a zeolite system to remove scale-forming substances, and both the water and the oil are cooled during each cycle.

Cooling is done in a Fluor induced-draft, wooden tower over which raw water from a 500-foot well is pumped at a rate up to 125 gpm. The tower also serves to cool the outgoing gas the temperature of which is increased by its passage through the compressors. Cooling reduces the volume of the gas, thus enabling the line to carry more, and also tends to prevent expansion of the transmission system that would be induced by heat. Combustion air for the compressor engines is taken from outside the building, and the intakes are equipped with Air-Maze filters to remove dust and other trouble-breeding substances. The station is operated by an engineer and an oiler on each of the three shifts, with an assistant superintendent in charge, making a total of seven men.

Burnett Station handles approximately 10,000,000 cubic feet of gas daily, taking it from ten wells at an average pressure of 158-160 psi., and discharging it at 240 psi. into an 8-inch line that delivers it to the Skellytown main-line station 6 miles to the east. Its single

Ingersoll-Rand Type XVG compressor has eight 11x12-inch power cylinders and three single-stage 8x18-inch compression cylinders. As already mentioned, the Burnett Station is unattended and full reliance is placed on mechanical safeguards to keep it functioning normally.

Water and oil for the engine-compressor are cooled during each circulating cycle by passing them through an outdoor radiator-type cooler that acts on the same principle as an automobile cooling system. Air is drawn through the radiator fins by a fan mounted on one end of a shaft that extends through the wall into the building and driven by V-belts taking power from a pulley on the end of the XVG shaft, outside the flywheel.

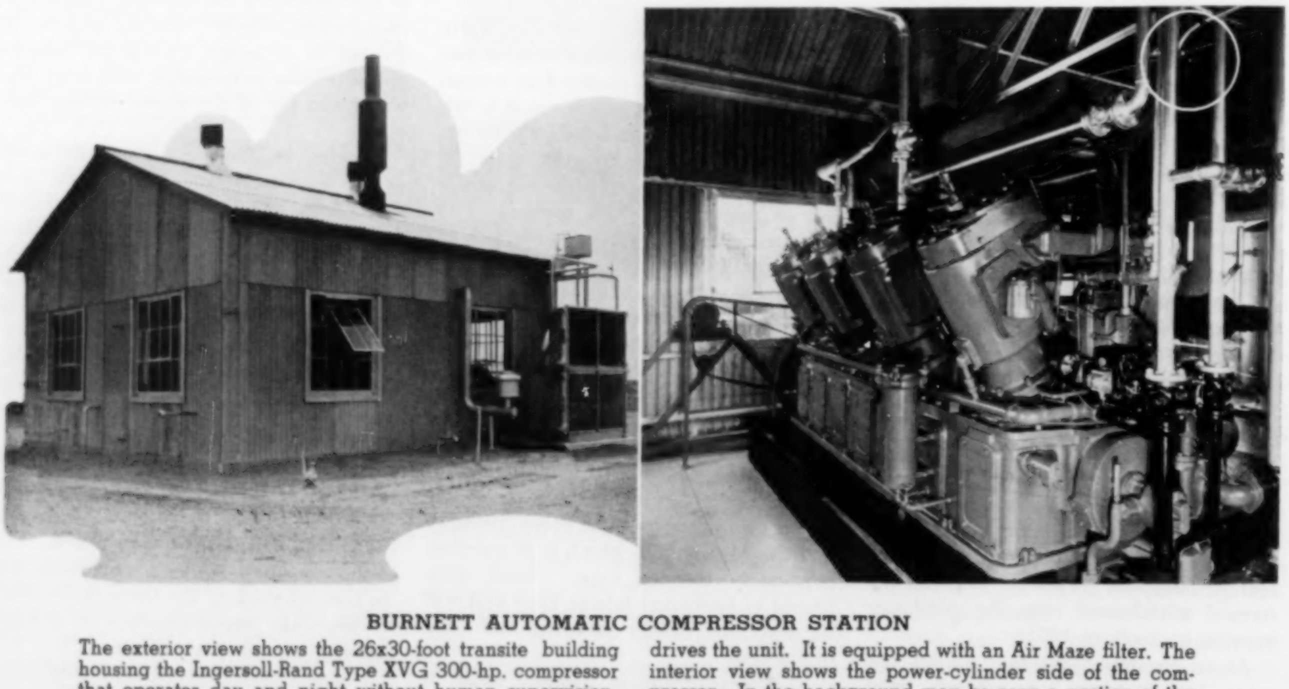
The radiator is divided into two sections—one for water and the other for oil. Water leaves the engine-compressor at 145°F. and is cooled to 127° for recirculation. Oil is cooled from 103° to 97° during each cycle. Called the Young-Happy, the radiator is manufactured by the Young Radiator Company of Racine, Wis., and distributed by the Happy Company of Tulsa, Okla. Chemically treated water for the cooling system is hauled in, and a supply of 500 gallons is stored in an underground tank to make up for losses as required. That quantity, experience has shown, is sufficient to meet the needs for several months. Engine combustion air is piped into the building from outside and filtered by an Air-Maze unit on the intake.

Although no one normally visits the station oftener than once a day, there is little chance that the engine-compressor will damage itself in case anything goes wrong because various safety devices with which it is equipped will shut it down instantly if any of the more-likely-to-occur troubles develop. These devices are all provided by the manufacturer, and, while others could be added, that is not considered necessary. One of these safeguards is an overspeed shutoff consisting of a weight-and-plunger arrangement that acts to ground both engine magnetos should the governor fail to control the engine speed. The normal operating speed is 340 rpm., and the device comes into play if it rises to 425 rpm. If the pressure of the oil supplied to the main bearings falls below 20 psi., a mercoid-type switch stops the engine by grounding the magnetos. In a similar manner, the machine is shut down if the water in the cylinder jackets rises above a prescribed temperature or escapes.

The control unit is located at one end of the exhaust manifold of the No. 1 power cylinder and has a bulb immersed in the cooling water, with connecting wires to mercoid-type switches for grounding the magnetos. So as to prevent overloading the machine, mercoid switches, mounted on small receivers on both the intake and discharge sides, will stop the unit in the event either the intake or the discharge pressure rises a predetermined amount. Finally, an oil-pressure-operated valve shuts off the supply of fuel gas to the engine if the latter is idle for any of the reasons aforementioned. When it stops, the bearing-oil pressure falls to zero and that actuates the gas shutoff valve.

If the machine stops running, that fact will soon be known at the Skellytown Station through the medium of a telephone hook-up. A transmitter that hangs above and near the V-type power cylinders of the Burnett unit is connected to a circuit that terminates at a listening post in one of the Skellytown buildings. At regular intervals a member of the operating crew there takes down the receiver and holds it to his ear. If he fails to hear the familiar sound of the engine, someone is immediately dispatched to the station to ascertain the cause of the stoppage and to get the machine back into service. Fortunately, the need for this rarely arises. In its first year of operation, which ended on December 4, 1949, the unit was shut down by the safety devices only twice. On three other occasions the machine was stopped to make adjustments or repairs.

EDITOR'S NOTE: Since the foregoing article was written, a second Type XVG compressor has been installed at Burnett Station. With two machines now normally in service, the telephone "listening-post" system would not give notice if one of them stopped. Consequently, it is being replaced with telemetering equipment that will transmit information on the operation of the engines to the Skellytown Station. Burnett Station will continue to function unattended.



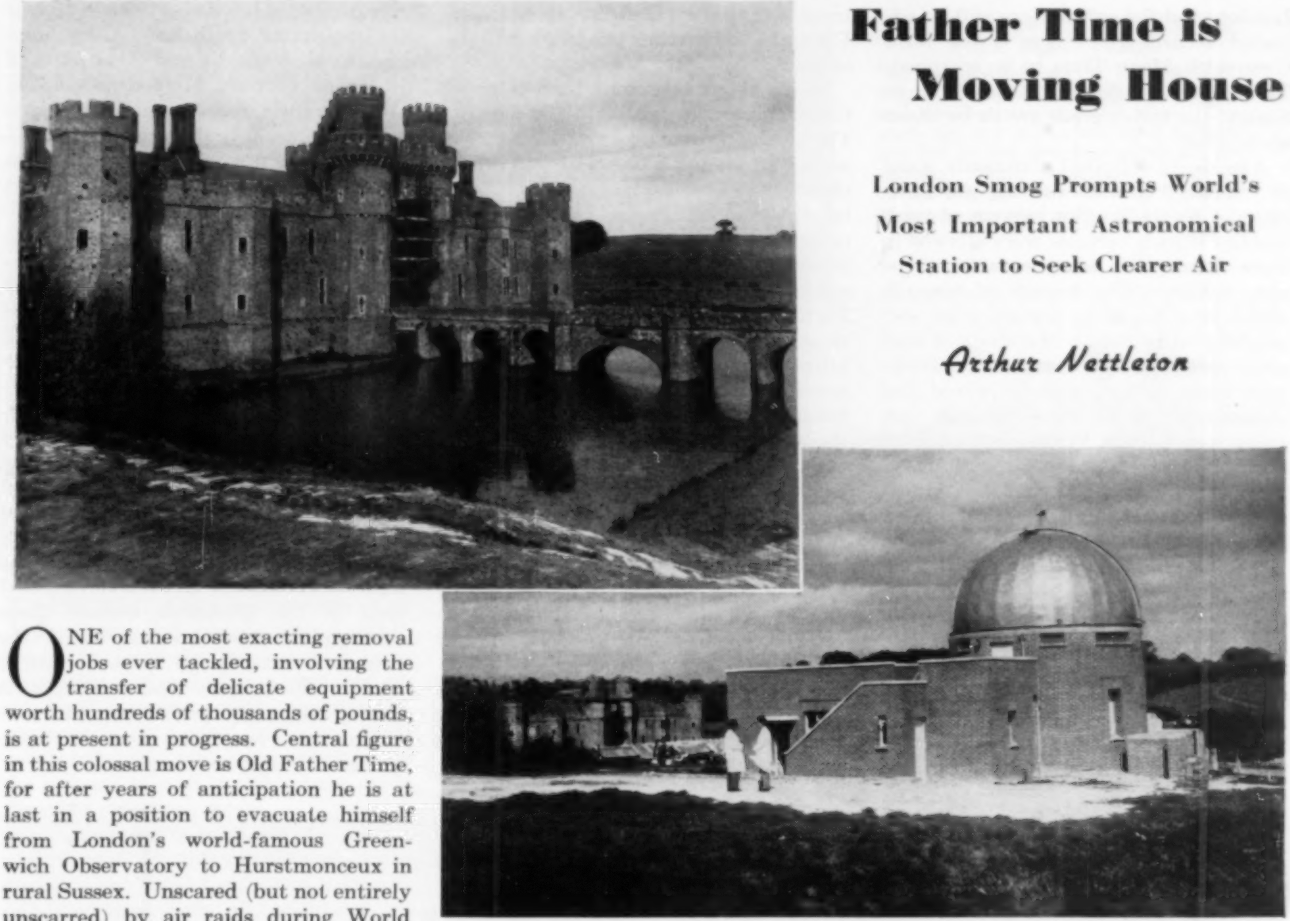
BURNETT AUTOMATIC COMPRESSOR STATION

The exterior view shows the 26x30-foot transite building housing the Ingersoll-Rand Type XVG 300-hp. compressor that operates day and night without human supervision. At the right is a radiator behind which is a fan that draws air through it to cool the compressor circulating water and lubricating oil during each cycle. Treated water to replenish the supply when required is tapped just above the ground surface at the left of the radiator from a 500-gallon underground tank and is introduced into the system through the boxlike structure above the radiator. Just beyond the tap is the intake for combustion air for the gas engine that drives the unit. It is equipped with an Air Maze filter. The interior view shows the power-cylinder side of the compressor. In the background may be seen a portion of the arrangement for driving the fan (partly visible through the window) that serves the outside radiator. It consists of V-belts that extend from a pulley at the far end of the compressor main shaft to another pulley on the end of the fan shaft, which projects through the wall of the building. The telephone transmitter shown in a picture on the first page of this article is at the upper right-hand corner with a white circle around it.

Father Time is Moving House

London Smog Prompts World's Most Important Astronomical Station to Seek Clearer Air

Arthur Nettleton



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NEW OBSERVATORY SITE

Hurstmonceux, a village in Sussex to which the Greenwich Observatory is gradually being moved, became known principally for the fifteenth-century castle built there by Sir Roger de Fiennes. The original structure is now largely in ruins, but materials from it were used in the eighteenth century to build what is known as Hurstmonceux Place, a mansion (top picture) that has all the appearances of a castle, even to the moat. It will house some of the observatory facilities, while others will occupy new structures. The first of the latter, the Solar Building, which contains a new telescope, is shown above.

ONE of the most exacting removal jobs ever tackled, involving the transfer of delicate equipment worth hundreds of thousands of pounds, is at present in progress. Central figure in this colossal move is Old Father Time, for after years of anticipation he is at last in a position to evacuate himself from London's world-famous Greenwich Observatory to Hurstmonceux in rural Sussex. Unscared (but not entirely unscarred) by air raids during World War II, he has not been prompted to take this step by threats of a future atomic bomb, but by London's ever-thickening smoke pall.

More than fifteen years ago Britain's leading astronomers realized that smoke haze over Greenwich was handicapping their observations. Stars and other heavenly bodies visible through the gigantic telescopes only two decades earlier had become hidden from view. Even the instruments themselves were being injured by chemicals in the polluted atmosphere. So search for a new home for stargazing was begun. Choice fell eventually on Hurstmonceux, where crystal-clear air and long hours of sunshine will, so the scientists believe, enable them not only to conduct research with more facility but, perhaps, to bring about new discoveries.

More than £500,000 ($1,400,000) will be spent on the transfer. One of the biggest tasks will be that of moving and resiting the mammoth telescope, called the Great Equatoria. Its huge weight and tremendous length will necessitate conveying it from London in stages, at night, so that other traffic will be inconvenienced as little as possible. This instrument and some other big ones will not be housed in Hurstmonceux mansion itself because the fabric and foundations of that turreted, brick-built structure are not sufficiently stable. Instead, special concrete foundations have been prepared for the telescopes in the surrounding park; but the administrative, research, and record work will be carried out in the mansion.

Sixty-year-old Sir Harold Spencer Jones, Britain's Astronomer Royal (a post that dates back to the days when Charles II permitted John Flamsteed to stargaze from one of the turrets of the Tower of London and, later, commanded Christopher Wren to design the nucleus of the present Greenwich Observatory), is already living at Hurstmonceux to supervise the transfer. He reports that the job will not be finished until 1953; but the new astronomical center will then be equipped to undertake research far more efficiently than at Greenwich.

The work that is being carried out by the Astronomer Royal and his staff is of international importance and of more than academic interest. Navigators of most countries depend upon the lunar tables prepared by these British scientists. From them mariners everywhere are able to determine, with the aid of chronometers tested and passed at Greenwich, their exact positions on the oceans of the world. Air almanacs for the use of aviators are issued in the same way.

But the influence of Greenwich on international activities began long before man managed to fly. Nearly 100 years ago the nations agreed to make this Thames-side station their official timekeeper. Regular time-signals are relayed to the world's capitals so that clocks everywhere may show the correct time.

Our maps use the Greenwich meridian as their basis of longitude. Greenwich was chosen as the center for this purpose more than 60 years ago by popular vote at an international conference. To alter the 'O' line of longitude would be to render all the maps and charts obsolete, so it is not to be revised by Father Time. Allowance will be made for the distance separating Hurstmonceux from

London, and the calculations will be adjusted accordingly. Nor is the term Greenwich Mean Time to be scrapped. Though the readings will be taken in Sussex, the time signals are to be based on London.

Amazingly delicate instruments, some so "touchy" that the readings would be affected by the ignition system of automobiles if such vehicles were allowed in their vicinity, are being installed at the new station. One branch of research which it is hoped to pursue more successfully with them is the study of sunspots and their effect on radio. Greenwich scientists have already proved that atmospheric interference through sunspots has a considerable influence on radio signals. Now, with improved facilities at Hurstmonceux, they aim to forecast just when and where solar interference will affect radio transmissions.

The long-term aim is to render all submarine telegraphic and telephonic cables obsolete. So far, the submarine cable has not been supplanted by radio communication because it is less subject to interference. But if enough data can be gathered to forecast the time and place of solar disturbances, rerouting of radio messages will be possible and "difficult" areas can be avoided at such times. Then the submarine telegraph will be outdated.

Much bigger telescopes than those at Greenwich are to be set up in Sussex. There would have been little point in adding to the instruments at the former observatory because they could not have been used to best advantage. At Hurstmonceux, however, with its clear atmosphere, a monster 100-inch reflector telescope can be used to full effect. Already, Parliamentary sanction for the construction of such a giant has been obtained, and statutory steps have been taken for defraying the cost out of public funds. The new instrument will not be the biggest in the world, but it will match the one on Mount Wilson, Pasadena, Calif., and will embody several new ideas. Its total weight will exceed 100 tons, the mirror alone accounting for more than 4 tons. Care will be taken to avoid one of the shortcomings of the Mount Wilson telescope. That instrument cannot be trained on any stars over the North Pole.

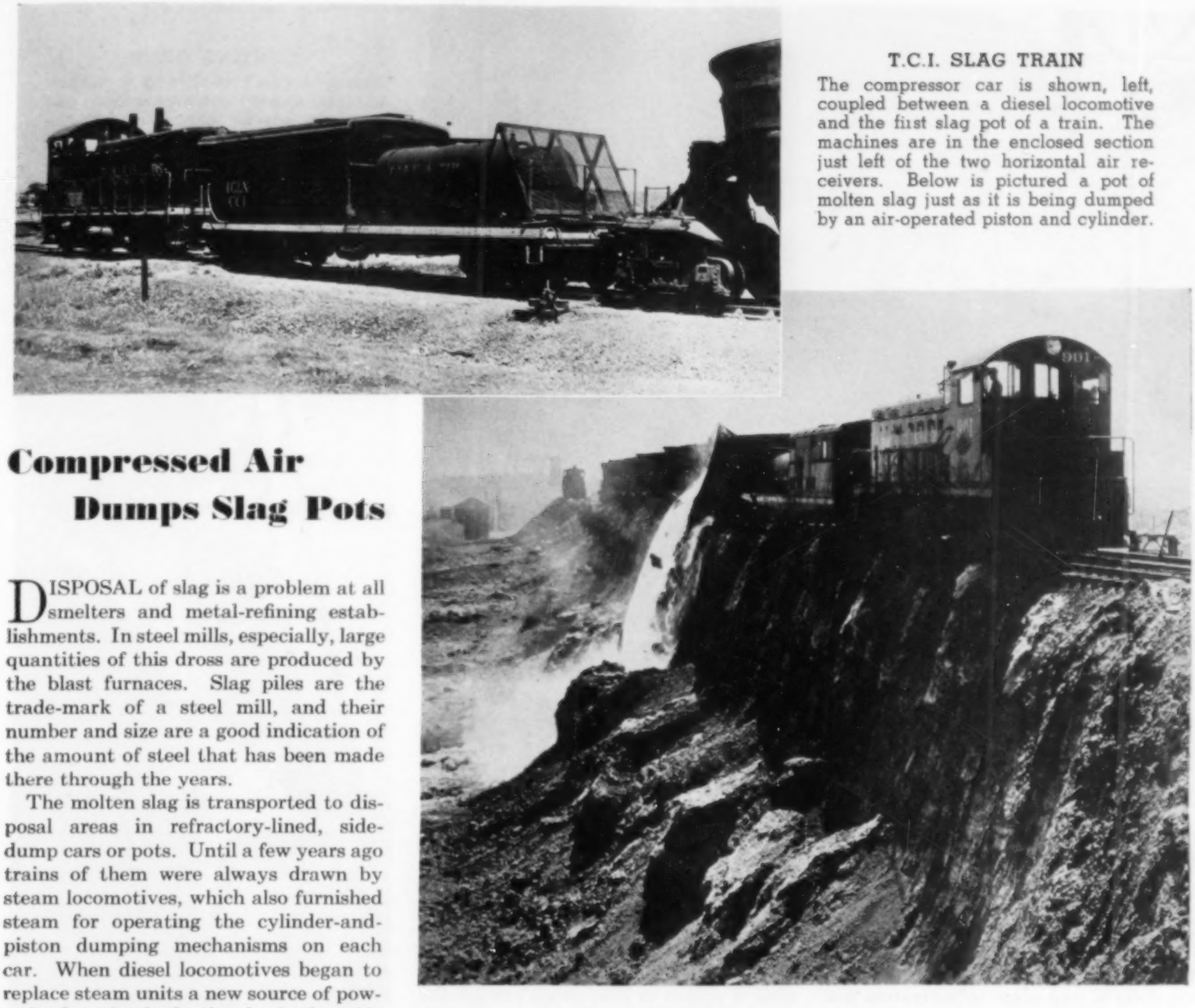
American benefactors have already helped to equip the British Astronomer Royal's new observatory. The trustees of the McGregor Fund of Detroit, Mich., have presented it with a $100,000 optical lens measuring 98 inches. Gifts have come from Australia and other parts of the British Empire. Melbourne has sent a new "transit circle," a piece of equipment that checks the length of the day—23 hours, 56 minutes, and 4 seconds, to be exact. It replaces one that has served at Greenwich for precisely 99 years!

Greenwich astronomers are also actively concerned with weather forecasting, and this work is to be expanded in Sussex. Better facilities will be provided for collecting, studying, coördinating, and disseminating meteorological reports from all over the globe.

Hurstmonceux is redolent with history, its story going back to Norman days. William the Conqueror gave the manor to one of his kinsmen, and a castle was built there during the reign of Henry VI (1421-71). The present mansion of mellow brick dates back to the eighteenth century. But it is certain that none of the illustrious owners down through the ages ever envisaged the baronial estate as the home of Father Time. His transfer and settling-in is presenting many problems; yet, once completed, a new novel phase in Hurstmonceux history will begin.

HISTORIC GREENWICH OBSERVATORY

Founded in 1675 to trace the moon's position day by day and to work out tables for the determination of longitude at sea, the institution has always occupied the structure shown at the right. The inscription "Flamsteed House" over the doorway honors John Flamsteed, early astronomer who was appointed "astronomical observator" by royal warrant the year the observatory was established. Flamsteed catalogued more than 3000 stars and made notable contributions to the present system of measuring time. Greenwich Observatory is the world's chronometer, and all time is determined there. Until 1878, American railroads ran on "local" time and there was great confusion. Upon the suggestion of Sandford Fleming, a Scotch Canadian, the present standard system was adopted. The globe was divided into 24 zones, their centers marked by meridians of longitude spaced 15° apart. Going westward from Greenwich, there is a time lag of one hour for each succeeding zone. To keep all timepieces synchronized, Greenwich Mean Time is flashed around the earth at regular intervals. The picture below shows a section of the department that adjusts and repairs all timepieces used by the British Royal Navy.



T.C.I. SLAG TRAIN

The compressor car is shown, left, coupled between a diesel locomotive and the first slag pot of a train. The machines are in the enclosed section just left of the two horizontal air receivers. Below is pictured a pot of molten slag just as it is being dumped by an air-operated piston and cylinder.

Compressed Air Dumps Slag Pots

DISPOSAL of slag is a problem at all smelters and metal-refining establishments. In steel mills, especially, large quantities of this dross are produced by the blast furnaces. Slag piles are the trade-mark of a steel mill, and their number and size are a good indication of the amount of steel that has been made there through the years.

The molten slag is transported to disposal areas in refractory-lined, side-dump cars or pots. Until a few years ago trains of them were always drawn by steam locomotives, which also furnished steam for operating the cylinder-and-piston dumping mechanisms on each car. When diesel locomotives began to replace steam units a new source of power for dumping had to be obtained, and it was only natural that many mills should adopt compressed air. One reason for selecting it was that the existing piping and dumping mechanisms could be used. Furthermore, no material change in the working procedure was involved.

Although a diesel locomotive is provided with a compressor to supply air for actuating brakes, the machine has insufficient capacity to take care also of the slag-pot dumping job. Consequently, other compressors have to be installed, and because there is not room for them in the locomotive they are housed in a separate car. Details of the provisions made to accommodate them vary among different mills.

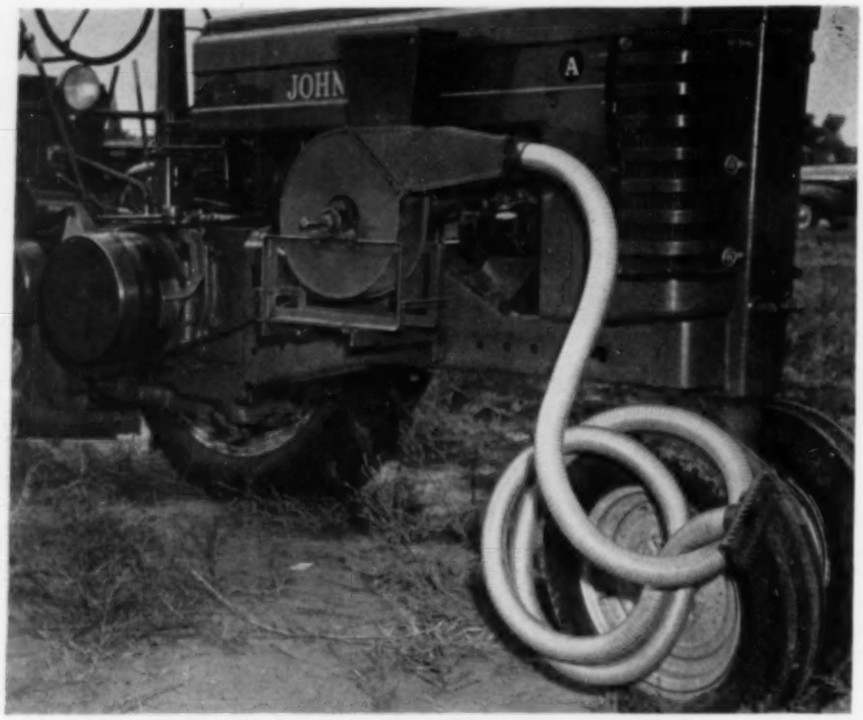
Accompanying pictures show one of the slag trains that serve the Tennessee Coal, Iron & Railroad Company, United States Steel Corporation's subsidiary in the Birmingham, Ala., area. The changeover from steam to diesel locomotives was begun there in the summer of 1948, and six units—each with its own compressor car—are now in operation.

The compressor car, which was designed by T.C.I. technicians, is coupled between the locomotive and the first slag pot of the train. It is divided into three sections. On an open platform at one end are mounted two large air receivers with connections to the piping that extends back along the train to the slag pots. In the central section, which is housed, there are two Ingersoll-Rand Motorcompressors, each of which has a piston displacement of 284 cfm. and is driven by V-belts from a Reliance 50-hp., 125-volt, direct-current motor. At the end nearest the locomotive is a closed compartment provided with seats for the train crew. This shelter is a distinct improvement over the open tow cars on which the men formerly rode.

Power for operating the compressors is drawn from the locomotive's generator. Whereas considerable work was involved in connecting steam fittings to the boilers of the old coal-burner, the new diesel system requires little more than a flick of the engineer's fingers. Moving a small lever transfers current from the propulsion motors to the compressor motors. This permits filling the air receivers while the locomotive is idling, and their large storage capacity insures an ample volume of air to tip all ten pots that generally constitute a slag train. The air is stored at a pressure of 100 psi.

The pots are dumped by throwing a switch in the locomotive cab. Each is mounted on a short underslung car between two 4-wheeled trucks of standard railroad gauge. The nature of blast-furnace slag is such that mere tipping of a pot will not empty it completely. Slag quickly solidifies around the sides of the vessel, forming a crust that steelmakers call "skull." To jar this loose it is necessary to tilt the pot with such force that its side strikes sharply against the frame of the car. After it is emptied the piston-cylinder mechanism brings it back to normal position.

Several other steel plants are using diesel-engine-driven compressors. Of the compact, portable contractor's type, they are stripped of their running gear and mounted in railroad cars. A unit of this type makes the dumping operation independent of the locomotive as a source of power. Coupled to the slag cars or spotted on a track alongside a halted train, it releases the locomotive for other work while the pots are being emptied.



DUSTING GRUB

Raking a cow's back with a toothed scraper (below) removes scabs, and rotenone powder blown through the hose then kills the exposed grubs. The air is supplied by a blower, into which the rotenone powder is fed from an overhead hopper. The unit may be operated by power take-off from a tractor, as shown at the left, or by a gasoline engine or an electric motor The duster is manufactured by Fleischer-Schmid Corporation.

Cattle-Grub Duster Saves Time and Money

ANNUAL losses attributable to the heel fly, sometimes called the gadfly, and its larvae—cattle grubs—are estimated to amount to at least 50 million dollars, and some investigators put them as high as 100 million. The damage done affects cattlemen, dairymen, packers, tanners, and, ultimately, consumers.

The activity of one heel fly, according to the U. S. Department of Agriculture, is at times sufficient to stampede an entire herd of placid cattle. The insect does not sting or inflict pain, as many persons believe, but cattle are instinctively terrorized if they feel or sense its presence. The fly settles on the hoof or lower leg to deposit its eggs. At once the animal or host shows apprehension, then fear, and finally starts on a mad rush to elude the pest, tail hoisted in a gesture which to all cattle unmistakably means the presence of a heel fly. In the subsequent scramble they may rush over cliffs and through fences. In addition to immediate injury, the animals, huddling in shade or standing in water, may refuse to feed and thus lose or fail to gain weight. Calves are deprived of milk, or the dairyman suffers a heavy loss through a decline in milk production.

The fly deposits its eggs on hair close to the skin where, warmed by the host's body, they hatch within three to five days, the tiny larvae forcing their way through the hide into the deeper tissues. After about nine months they reach the back of the animal, where each one makes a hole in the skin. Shortly thereafter a pocket or cyst forms around the larva. When the latter is ready to leave the host, it works its way out, drops to the ground, and becomes first a pupa and eventually, when the temperature is favorable, a new heel fly.

Grubs cause tremendous losses in leather. Commonly as many as 40 holes, and sometimes more than 100, are found in a single hide. Cattle slaughtered for meat before the larvae have infested their backs exhibit patches which must be trimmed away and discarded. Even though the quality of the meat is not affected, trimming disfigures the carcass and reduces its salability.

Extensive research by scientists of many countries indicates that the best time to attack the pests is when they are in the backs of the cattle and accessible through the holes they have cut in the skin. The most satisfactory agent found for killing the parasites at that stage is the finely ground root of tropical plants containing the element rotenone, which is widely used as an insecticide. When properly applied, the powder kills nearly every larva without injury to the animals. Where used systematically, there has been a marked reduction in the number of heel flies and grubs.

One method of application is to sift the dry insecticide lightly over the back, rubbing it into the coat of hair with the hands. This procedure is effective but slow and tedious, especially if many cattle are involved. Another is to mix the powder with water and to spray the solution on. Wetting, to which many ranchers object, is avoided by the new, fast method for killing grubs illustrated here. In one operation it removes the scab and instantly blows the rotenone formula directly into the cyst. The 6-inch-wide scraper on the nozzle is used to avoid missing stray larvae. If necessary, the operator can turn off the powder supply to avoid waste in going from one animal to another. The manufacturer claims that the grub duster can treat about 60 head of cattle an hour and that use has proved it to be a successful means of fighting the pest.

This and That

New Life for Old Gold Camp Cripple Creek, Colo., expects to begin its gold-mining comeback before the year ends. The Golden Cycle Corporation's new $1,500,000 ore treatment mill now taking form in the mining area is scheduled to go into operation next September. A construction force of more than 100 is working seven days a week and will be increased to 225 as soon as spring breaks. The structure will be 463 feet long and 413 feet wide and built on a hillside so as to provide gravity flow. Its initial capacity of 1000 tons daily can readily be increased to 1500.

Meanwhile the Cresson Mine, reputedly the world's leading gold producer per acre of surface area, is being equipped with an electric hoist capable of lifting ore 4000 feet. As a result of drainage through the million-dollar Carlton Tunnel, which was driven by Golden Cycle Corporation in 1939-40, a vertical section averaging 1100 feet thick underlying this property and others can now be operated without the expense of pumping water. All the one-time prosperous mines still had ore of good grade in their lowest workings when the war-time ban on gold mining shut them down.

The new mill will replace the Golden Cycle plant at Colorado City which treated the bulk of the Cripple Creek ores from 1905 until February, 1949. Instead of loading the ore in railroad cars and shipping it 50 miles, as in the past, it will reach the new mill in trucks after an average haul of around 3 miles. This reduction in cost promises to permit treating profitably millions of tons of low-grade dump ore in addition to the current output of half a dozen mines with proved payable deposits.

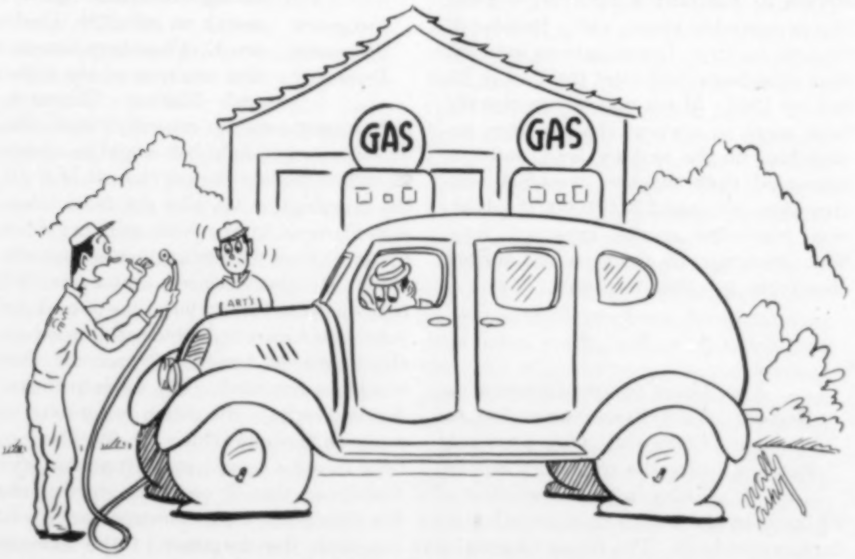
With the passing of the old mill, company officials announced that it had recovered $200,000,000 in gold from 14,500,000 tons of ore. The latter quantity is equivalent to 290,000 carloads of 50 tons each. In order to equal this record, the new mill will have to work at full capacity for 40 years.

* * *

Volts from Eels Although the secret of how certain fishes generate and discharge electric currents is still largely shrouded in mystery, many general facts regarding these curious creatures are now known, according to C. W. Coates, curator of the New York Aquarium. Writing in Electrical Engineering for January, 1950, he classifies the electric eel as the most potent power producer among them. This fish, which lives in the fresh waters of tropical South America, can release electrical discharges at a rate as high as 300 to 400 per second. It ordinarily uses this power to obtain food and to protect itself, and as it frequents the shallow edges of the water it sometimes shocks and even kills horses and cattle that come there to drink. Ranchers and cowboys consequently carry machetes with insulated handles and quickly chop to pieces every eel they see.

Ancient peoples knew of electric fishes even before the nature of electricity itself was known. The Egyptians looked upon the electric catfish as sacred and pictured it in their hieroglyphs. Under the belief that it would transmit electric currents up the lines if trapped in a net with other creatures and thus cause fishermen to release the catch, they called it the Protector of Fishes. Another Mediterranean electric fish, the torpedo, was called *narke* by the Greeks, a term from which our word narcotic was derived. Some early physicians prescribed shocks from these fishes for certain illnesses, proving that electrotherapy is not of recent origin. An 1877 London advertisement urged sufferers from gout and rheumatism to take shock treatments at two shillings and sixpence each. Volta, Benjamin Franklin, and other pioneers in the field of electrical research studied electric fishes.

"O.K. Fred, as soon as I dry off I'll help you shower."



"Golly, this air hose is working in reverse."

* * *

To Reopen Old Mines in Greece Ore deposits in Greece that were, it is reported, worked as long ago as 1200 B.C., are to be mined by a Canadian company backed largely by U. S. Government funds. The Economic Cooperation Administration has granted a 10-year loan of $430,000 to Mediterranean Mines, Inc., and will provide additional capital of $195,000 with which to sink shafts and build a 200-ton flotation mill at the southern tip of the Attica Peninsula. Known locally as the Greek Laurium properties, the ancient mines consist of open pits and shallow shafts extending along some 15 miles of surface. The flat-lying ore bodies contain values in zinc, lead, and silver.

The early workers took out the surficial oxides, leaving the deeper sulphides because they had no way of treating them. The deposits then remained untouched until around 1860, since which time operations have been sporadic. French interests now hold a concession covering the central section of the mineralized area which is surrounded by the

Canadian holdings. Preliminary explorations have disclosed an estimated 300,000 tons of ore grading 5 percent in lead, 6 percent in zinc, and 2½ ounces in silver to the ton, and it is believed that much greater quantities lie at deeper horizons. In addition, there are about 2½ million tons of old mill tailings containing from 2 to 4 percent of lead and 2 ounces of silver per ton that can probably be treated profitably by flotation.

★ ★ ★

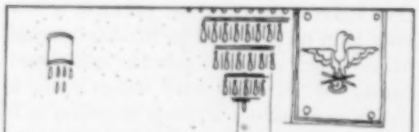
Mining Is Big Business

Figures recently issued by the Transvaal Chamber of Mines graphically portray the hugeness of the gold-mining operations in South Africa. In the course of a year, pneumatic rock drills in Rand mines put in 60,000,000 blast holes, an average of 200,000 daily. In detonating the powder placed in them, 300 miles of safety fuse is consumed every day. A year's purchases of explosives runs to more than 1,850,000 cases. In addition to handling ore and supplies, the mine hoists transport around 146,500,000 passengers annually, or more than a fourth as many as are carried by the London underground railways. That the hoistways constitute one of the world's safest transportation systems is attested to by the fact that in the past sixteen years there has been only one rope breakage for every 100,000,000 trips made.

★ ★ ★

Sturdy Plane Tires

Impressive progress in pneumatic-tire development is reported by The B. F. Goodrich Company concerning the tires on the Navy's new Douglas Skyrocket airplane. Although each of the two on the main landing gear is about the size of those on a Crosley automobile and the one on the nose gear is smaller, each of them will carry a load eight times as great as will an average passenger-car tire. Of 12-ply, Nylon-cord construction, the tires are inflated to 200 psi. pressure and have a bursting strength exceeding 1000 psi.



"I never thought I'd be having lunch in the White House."

★ ★ ★

U.S. Jigs to Capture Diamonds

Machinery developed in the United States for treating ores will soon dispense with the need of 300 native diamond sorters at the Williamson mine in Tanganyika, Africa. Diamond-bearing earth has been concentrated in mechanical pans, but many small stones escaped in the washings and had to be picked out by hand. Under the new system a series of sixteen jigs, made by the Denver Equipment Company, will supplement the panning operation. Experiments with a pilot plant have indicated that no diamonds large enough to be of commercial value will get by the jigs. The installation will handle from 1100 to 1200 tons of material in twenty hours, and the remaining part of each day will be spent in cleaning up.

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Coastal Subsidence Continues

Since 1937 the ground overlying the Wilmington Oil Field in California has subsided approximately 9 feet. Attributed to the withdrawal of the underlying fuel, sinking continues as 2000 wells go on extracting around 123,000 barrels of oil and 64 million cubic feet of gas daily. Surface structures in the area are valued at $500,000,000 and include the Long Beach Naval Shipyard, extensive Los Angeles and Long Beach harbor facilities, the largest electric generating station in Southern California, a Ford Motor assembly plant, and a Proctor & Gamble factory. Investigations indicate that subsidence will total from 18 to 23 feet by 1963. Much money has already been spent to prevent the sea from encroaching on the sinking land, and it is estimated that effective remedial construction will cost $30,000,000 if subsidence continues at the expected rate. The alternative is to move the surface structures to other locations.

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Record Furnace Bottom

Using pneumatic rammers, Basic Refractories, Inc., of Cleveland, Ohio, recently placed a refractory bottom lining in the record time of 57 hours in the largest open-hearth steel furnace yet built. The lining material is Ramset, made by mixing a granulated magnesia clinker with water to form a plastic of the desired consistency for cold ramming. The furnace, owned by Weirton Steel Company, has a bath or melting compartment 58x18½ feet in floor area and 45 inches deep. The refractory was applied to a thickness of 13 inches in the center and 15 inches at the ends. It was mixed with water in concrete mixers stationed outside the furnace and carried in by a bulk conveyor, a total of 170 tons being used. Seven pneumatic tampers were operated uninterruptedly to consolidate the mass. Three days after the bottom was in place twelve cars of railroad ties were fired to "burn it in." On the fourth day the first heat of metal was tapped from the furnace. The charge consisted of 504.7 tons of metal, ore, and limestone, from which 457.8 tons of metal was produced. This is as much as is embodied in 400 automobiles.

"Best purchase I ever made."

★ ★ ★

Tungsten Filament Economy

Citing the value of research to industry, Dudley E. Chambers, executive engineer of the General Electric Research Laboratory, stated recently that the nation's annual light bill would be about 12 billion dollars higher than it is if all the illumination we now get from tungsten-filament lamps were still provided by the carbon-filament type used prior to 1906. He also declared that extra fuel equivalent to 200 million tons of coal per year would have to be burned to produce the increased amount of current that would be required. The modern incandescent bulb is the direct outgrowth of research through which Dr. W. D. Coolidge found a way to make tungsten wire ductile so that it could be drawn into fine filaments. Those now used are about one-sixth the diameter of the average human hair, and a single pound of tungsten produces about 125 miles of them.

EDITORIALS

COMPRESSED
AIR

THE PAST 50 YEARS

AS WE approach the midcentury (technically, we won't reach it, the experts say, until 1951) it is natural to look back and see how we have fared in the past 50 years. To the world at large the waning half-century has brought some bad headaches. Two global wars and a depression of unprecedented severity were about all it could absorb. The ferment of the most recent international conflict is still working, and there is political instability throughout much of the whirling sphere on which we live.

Economically, the United States has become storekeeper and banker for most of the other nations. In fact, Uncle Sam is now much in the position of the boy who has acquired all his playmates' marbles and has to redistribute some of them to keep the game going. Other nations are striving hard to find something we will accept in exchange for our goods and dollars, but at the moment trading is greatly out of balance.

Internally, we are still, as the saying goes, eating high off the hog. Employment, wages, and purchasing power are only slightly below their peaks, and the people at large continue to indulge their appetites for things they couldn't get during the war. Automobile sales remain at a high level, television masts are growing thicker, and Saturday-night throngs still have money to spend. Everything is up: prices, taxes, and optimism concerning the future, the latter inspired by a growing philosophy that a bottomless Federal treasury will provide for our old age. Some storm warnings have been flown, but the average citizen hasn't yet begun to think about getting out his umbrella.

On the technological side, the first half of the century outstripped any like period since time began. Vast new horizons were opened up. Thanks to new inventions and the efficiency of the machine age most Americans now live on a plane that was beyond the comprehension of our grandfathers. Unfortunately, not all the new things that have come along work exclusively for human welfare. The airplane has revolutionized transportation, but it has also made it possible for man to deal death at long range. Atomic fission holds forth the promise of great benefits, but it also spawns terrorizing bombs of devastating potency.

Eons ago, when primeval man fashioned the first spear, he unwittingly created a problem for himself—whether to use it solely to obtain food and clothing or also to exterminate his fellows. Ever since then, down through the discovery of fire, arms, dynamite, and other potential killers, succeeding generations have been faced with similar decisions. Except for its complexity, the problem has not changed greatly. Obviously, the destiny of mankind rests on how human emotions express themselves. Perhaps the next 50 years will bring us nearer the answer than we are today.

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COSTS: 1900 AND 1950

IN LOOKING through a copy of *The New York Times* of January 1, 1900, we find that a roast of beef was advertised for eight cents a pound and eggs for 22½ cents a dozen. A leading hotel offered a full-course New Year's dinner for 75 cents. Theater tickets ranged from 25 cents to a dollar each. A business firm had a job open for a stenographer at $7 a week.

Comparison of these figures with present-day quotations on corresponding items would seem to lead to the conclusion that the price of everything has risen sharply during the first half of the twentieth century. Actually, this is not true. In fields where technological advancement has been an important factor, there are numerous examples to the contrary. Consider electric light, for one. The same amount costs less today than it did in 1900, to say nothing about the better illumination now available.

Even where wages have mounted precipitously, increases and improvements in mechanical processes have boosted production per man-hour so much that the costs of goods turned out or services performed have, in many instances, gone up little if at all. A case in point is the average automobile; today it sells for less than it did in 1900 and gives a great deal more in comfort and convenience. Meanwhile, rising incomes have enabled the average man to own a car, whereas few people could afford one 50 years ago.

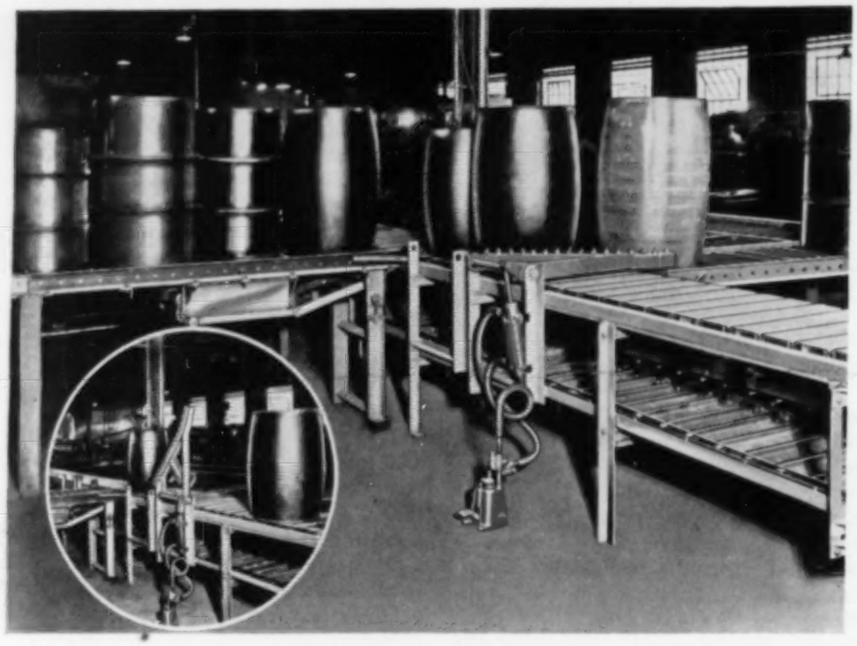
By way of another illustration, this one in the field that we cover, take rock-drilling costs. The subject is especially appropriate because a rock drill is a "fundamental tool"; that is to say, it enters into the excavation of all rock and ore, which is the starting point of most construction work and all our metalworking industries. In 1902, Edward A. Rix, an authority of the day on compressed air, wrote: "The average work of a rock drill for one shift is from 30 to 40 feet of hole drilled. The pay of miners is $3 a day for machine men, $2 for helpers."

Using these figures, we arrive at a drilling cost of from 12½ to 16⅔ cents per foot of hole, or an average of around 14½ cents. Miners now receive $12 a shift, and two are assigned to a drill when drifting. However, with modern machines on jumbo mountings and with Carset Jackbits two men can drill 133 feet of hole per shift. The cost per foot, on a wage basis, is approximately seventeen cents. There is an apparent margin of 2½ cents in favor of the 1902 performance, but that is wiped out when we consider that a shift was then ten hours as against the present eight. When analyzed further, the figures show 1.75 feet of hole drilled per man-hour in 1902 as against 8.3 feet today. In 1902, power for air compression per foot of hole was computed at the rate of five cents and that of equipment repairs at 0.06 cent. Because modern drills operate at higher speed, power costs less than it did in 1902, and the equipment repair bill is no larger than it was then.

That the unit cost of drilling has not risen appreciably in 50 years despite an almost fivefold increase in wages is attributable solely to the fact that the machines have undergone great improvement. The piston-type drill of 1902 delivered only 300 blows per minute, weighed 370 pounds, and was commonly operated from a tripod that weighed 272 pounds bare and much more with stabilizing weights attached to its legs. The factory shipping weight of one drilling outfit was 1095 pounds. This whole setup had to be moved with each change in hole location. The current hammer-type drifter drill is much lighter, strikes 2000 blows per minute, and is mounted on an easily maneuvered boom. The wheeled carrier jumbo runs on tracks and can be quickly shifted.

The superior drilling efficiency of carbide insert bits as compared with steel bits varies according to the character of the rock, but in all cases is so pronounced as to be startling. For example, in highly abrasive rock at the Holden Mine, in the State of Washington, 1,306,624 one-use steel bits drilled an average of 1.7 feet each in the years 1943-48. In seven months of 1949, on the other hand, only 957 carbide insert bits were required to drill 128,494 feet of hole, the average per bit being 134.3 feet.

Conveyor System with Pneumatic Switching Facilities



TYPICAL OPERATION

Drums on the filling line at the left are temporarily halted while the air-operated deflector in "down" position on the apron conveyor at the right shunts containers from another filling line onto a spur for storage. The deflector in the insert is being raised to permit the free flow of barrels to other spur points along the main conveyor. This selective carrier system is in use in a petroleum products plant.

HANDLING of drums and barrels can be coördinated as they are transferred from several filling points to storage and shipment by the use of a selective conveyor system devised by The Alvey-Ferguson Company. It combines gravity-roller, apron, and live-roller conveyors and features a number of air-actuated deflectors to help control the movement of the containers. Flow along any one of the converging lines is halted only momentarily, it is claimed, and there are no pile-ups, delays, lost motion, or unnecessary labor.

As they come from the filling stations, the drums proceed down the gravity-roller conveyors, each of which is provided with an automatic brake and an end stop that are brought into action when it is desired to halt the transfer of the containers onto the main or apron conveyor. Flow along the latter is controlled by the automatic air-operated deflectors, which shunt drums off the line onto the proper gravity-roller spurs to storage.

There are as many hinged deflectors as there are spurs, and each is lowered on to the apron conveyor in the path of the barrels or raised out of the way by means of a pneumatic cylinder. The latter is operated by a foot valve with air at approximately 80 psi. A chain-driven live roller conveyor, which parallels the apron conveyor, connects all the storage points and delivers the drums to the shipping station.

Another Tunneling Record

LAST month we reported on new rock-tunneling records established in December at the Owens Gorge Project in California. In editorial comment on them, we pointed out that it is difficult to compare progress in different bores on an equitable basis because so many variables are involved. A performance that would be considered mediocre in a tunnel where extremely favorable conditions prevail might, if duplicated under severe working conditions, be hailed as spectacular.

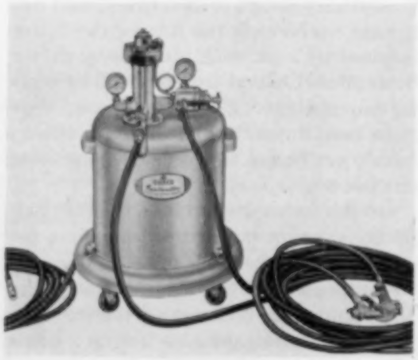
The size of the bore vitally affects the rate of advance. As a result there are records for various cross sections, although one would have a hard time running all of them down because there is no central clearing house for them. Owing to the uncertainty that exists in consequence, tunnelers who think they have set new marks announce them with some timidity, or even reluctance, because they are reasonably sure that somewhere, unknown to them, someone has bettered their performances. Also, because so many jobs are in progress at widely separated points it is difficult to obtain current reports and thus keep up to date on what the other fellow is doing.

Taking all these things into consideration, Morrison-Knudsen Company, Inc., of Boise, Idaho, claims that it has "apparently" broken existing records for driving a tunnel in the 24-foot size range. At the Big Creek No. 4 Dam Project near Fresno, Calif., crews working under Supt. Carl J. Herslof advanced a heading 222 feet in six days during last December. The best previous known record for a like period was a 206-foot advance made in 1948 in the 25-foot Rock Creek bore on the Feather River in California by Walsh Construction Company forces. That figure bettered one of 202 feet made six weeks earlier in another part of the same tunnel by Morrison-Knudsen men. Contributing to the latest mark at Big Creek were daily advances ranging from 33 to 41 feet.

New Spray-Paint Dispenser

NEW equipment for feeding paint to spray guns has been developed by Gray Company, Inc. Called Paintmaster, it comes in two sizes: one to fit over a 5-gallon container and the other over a 55-gallon drum. In either case, it delivers the paint direct to a gun by means of an air-operated gear pump. Meanwhile the paint is kept mixed by a propeller-type agitator on the lower end of a rotating shaft. When one drum is empty, the Paintmaster is transferred to a full one.

It is claimed that the appliance saves much time by eliminating the need of transferring paint from one container to another. Spillage also is done away with. Because air pressure does not act directly upon the paint, the latter is not aerated. For large-scale industrial operations two drums of the paint being applied can be equipped with Paintmasters. When one is empty, the second one can immediately be put into service, saving time that is ordinarily lost.



PORTABLE UNIT

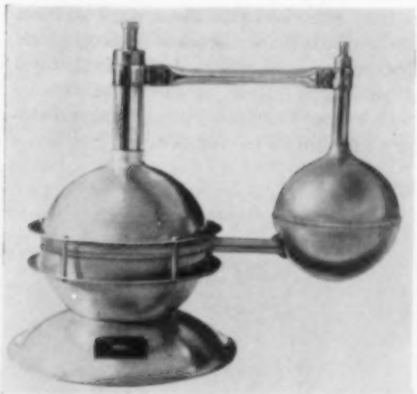
The 5-gallon Paintmaster is mounted on a wheeled base for maintenance work. A riser tube extends to within ½ inch of the container bottom to insure maximum removal of paint, enamel, lacquer, or other coating material.

Container for Rare Gases

LIQUID hydrogen and helium are almost chemical rarities because suitable vessels for them have never been commercially available. Hofman Laboratories, Inc., has recently patented its Liquid Hydrogen Container made of three concentric copper spheres. The inner and outer ones form a conventional vacuum flask, with interior surfaces polished to a mirrorlike finish. Between them is a third sphere, highly polished on both sides, which acts as a radiation shield. The latter is attached by an unusual connection to the inner sphere of a smaller side flask holding liquid nitrogen. The basic principle of the design is to reduce losses of the liquefied gases through evaporation.

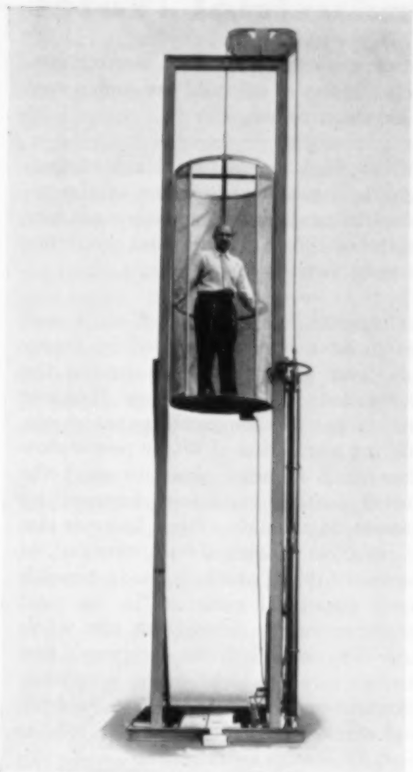
Because liquid hydrogen boils at an extremely low temperature, minus 250°C. (482°F.), it rapidly returns to the gaseous state even when it is placed in a conventional vacuum flask. The Hofman Laboratories' container limits this action by providing a cold barrier in addition to vacuum insulation and reflective surfaces. Through conduction, the radiation shield of the main flask is cooled to the temperature of the liquid nitrogen in the side flask. Thus evaporation losses of the liquid hydrogen or helium during storage and handling are reduced to a negligible minimum. Exhaustive tests are claimed to have proved that no other vessel for these rare and valuable liquids approaches the new product in efficiency.

The containers are available in three standard capacities—10, 25, and 50 liters—with side flasks of 5, 15, and 25 liters, respectively. Other sizes can be supplied upon request.



REDUCES LOSSES THROUGH EVAPORATION

The 2-flask liquid hydrogen container. The main or larger vessel is made up of three concentric copper spheres two of which form a vacuum flask while the other serves as a radiation shield. The latter, together with the liquid nitrogen in the small 2-sphere holder, keeps the hydrogen cool and thus prevents it from returning to the gaseous state. The main flask has a protective casing and base of spun aluminum.



ONE-PERSON ELEVATOR

The foreman of a large city newspaper has to make frequent trips between the first and second floors of the building, and he is usually in a hurry. If he uses the regular elevator he has considerable walking to do on both floors and, further, often has to wait for a car. Negotiating the stairway is both arduous and time-consuming. To solve his problem, the simple elevator shown here was constructed. Its steel framework rests on the first floor and extends up and through the ceiling. It carries a wire-mesh cage suspended from a wire cable that runs over pulleys at the top and is attached to the piston of an air cylinder mounted on one side of the frame. The cylinder, made by Ledeen Manufacturing Company of Los Angeles, Calif., is 4 inches in diameter, has a 114-inch stroke, and is operated with compressed air at 100 psi. pressure. Movement of the elevator is controlled from the cage by a foot switch connected to a solenoid valve.

By a system invented by a U.S. Air Force sergeant stationed in Japan, airplane engines can be prepared for storage at a considerable saving in time by the aid of a compressor. The engines are filled with an anticorrosive liquid contained in a tank into which air, drawn through a dehydrator before compression, is admitted. Under the pressure of the air exerted against the free surface of the fluid, the latter is "pumped" into the engine through a hose connection with a triggered nozzle, which is inserted into an opening made by removing one of the spark plugs. Where the system has been used it has saved 1000 man-hours a week.

Cleaning Machine-Picked Corn with Air

CLEANING corn as it is harvested mechanically is done efficiently by a new triple air-jet blower named the Flash-O Blower by its builder, the Fleischer-Schmid Corporation, of Columbus, Neb. Ordinarily, dirt, stalks, and loose husks are picked up along with the corn, and this debris must be removed during loading to enable the farmer to get a government loan on his stored crop. Clean corn is said to dry faster and offers greater protection against spoilage during prolonged storage periods. The manufacturer states that users of pickers report obtaining more shelled corn when the machines are equipped with the air-jet blower.

The combination corn picker-blower shown here is unique in that is has three powerful air jets located at key places: one is at the top of the husking bed and removes loose husks, stalks, and dirt picked up with the corn. Another directs a strong current of air up from the bottom of the bed, fluffing and loosening husks and silk to insure more thorough cleaning. The third jet keeps the hopper clean and prevents any remaining trash from moving up the elevator.

The blower, which operates through belt drive from a simple power take-off, is rugged and compact. Built of heavy-gauge steel with a sturdy frame, its shipping weight is only 100 pounds. The fan is provided with self-aligning ball bearings. The unit is designed for quick and easy mounting, there being no holes to drill, and is suitable for use with all popular makes of pickers, as well as with other farm machinery or services where a strong blower is needed.

BLOWER ON PICKER

Mounted on the rear end of a standard corn picker, the blower directs strong currents of air to three different places to insure thorough cleaning of the corn. The unit has a top speed of 3000 rpm., and can be used for curing hay in barns or serve elsewhere on a farm where strong air currents are needed. Tubing used is 4 inches in diameter and is of the flexible type.

Industrial Notes

Light and heavy industrial equipment can now be quickly and inexpensively identified and classified by markings that can't wear off, drop off, or get lost, according to the Handicraft Division, Burgess Battery Company, manufacturer of the new Vibro-Tool Marking Kit. The tool has a tantalum-carbide point and is said to write as smoothly as a pencil on steel or any other metal, plastic, wood, glass, or ceramic surface. Because of its light weight and even balance it rests easily in the hand, and its quiet, cool-running vibrator motor permits long use without fatigue on the part of the operator.

To what extent rubber is depended upon today to give motorists riding comfort is brought out by the following figures released by The Goodyear Tire & Rubber Company. In 1925 the average car boasted about 3 pounds of rubber, exclusive of tires. The 1950 models, with their 350 to 400 rubber parts, depending upon the make, need 94 to 143 pounds, of which tires and tubes account for 24 to 43 pounds.

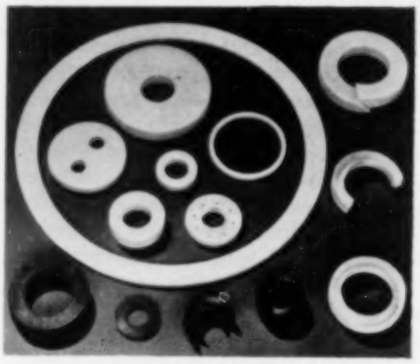
Grafize is a new lubricant put out in powder form by Reardon Products for home, office, or factory. It is applied by a refillable applicator of rubber and is said to act like graphite but, unlike the latter, does not soil clothes or hands. It can be blown dry into moving parts or added to oils or greases if greater lubrication protection is desired.

Here's a service that should appeal to householders burning coal for heating purposes, the only trouble is that, so far as we know, it is available only in Winnipeg, Manit. There a dealer delivers fuel to a customer as he needs it; a stoker feeds the furnace; ashes are stored in a pit alongside; and once a week, or at longer intervals, vacuum equipment is sent to remove the ashes while the service crew sweeps soot from heating surfaces. Many of us could use such a coal dealer-furnaceman.

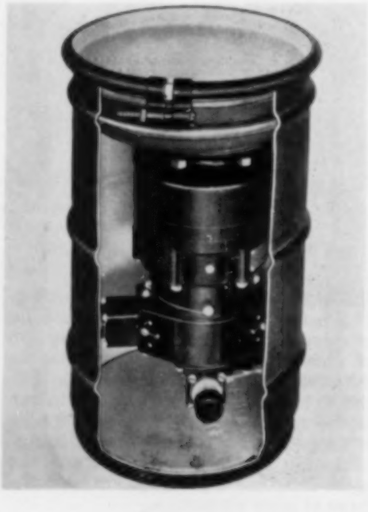
Glass that resists the attack of fluorides is a new development of the research laboratory and is being made into bottles of different shapes and properties to meet varying requirements.

Chipping hammers based on a new design have been announced by Ingersoll-Rand Company. Known as the Controlled Power Chipping Hammer line, it has a wide performance range, offering a selection of fifteen power sizes (five basic hammer sizes) to meet the varied cutting conditions imposed by present-day metals. Each hammer size is available in normal-cut, extra-cut, or supercut type, which is made possible by a structural variation in one part interchangeable throughout the whole line. Provided with the company's new Airite valve, which feeds accurately proportioned amounts of air to the front and rear of the piston, tools are said to maintain top cutting efficiency. Three different kinds of handles, which lock firmly in place, are available and enable operators to do their work with greater speed and less effort than formerly. All are of the open type with the trigger on the outside, as shown, or on the inside. By means of a new hard-surfacing process used exclusively by Ingersoll-Rand, piston life has been increased 12.3 times, it is claimed. Other important parts of the hammer that are subjected to wear also are plated.

Packing material which is chemically inert is offered in a wide variety of molded shapes under the name of Chemlon by the Crane Packing Company. Retaining all the properties of the familiar braided type, it is not attacked by acids or alkalis, and, according to the manufacturer, stands up for a long time under conditions never before successfully sealed by packing. It is effective at temperatures up to 450°F. and is said to have high flexibility, which is especially helpful in the installation of rings. When split, they can be twisted and placed directly on a shaft without completely removing the gland. The new molded styles are also claimed to have exceptional electrical properties including low power factor and low dielectric constant which make the material an excellent insulator for high-frequency transmission lines where low loss is an absolute necessity. Washers, rings, self-sealing "V" cross-section rings, ring gaskets, and jacketed (French) gaskets are standard forms, and many special shapes are molded by the company to meet individual requirements.

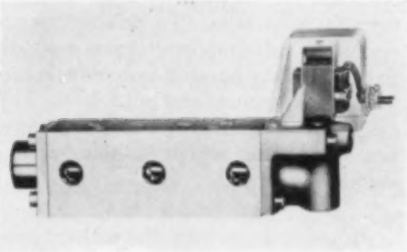


Steel containers used by the armed services during the war to keep shipments in condition for immediate use are now offered to industry by the Steel Drum Packaging & Acc. Inc., which was largely responsible for their development. Ranging in capacity from 4 to 55 gallons, they have an inner pack to hold the contents firmly in place with one inch clearance on all sides. Individual units of this type made as many as ten to twelve trips between manufacturers' depots and battle fronts. A supply of silica



gel is placed inside prior to sealing and will protect the contents even for ten years it is claimed. Typewriters, adding machines, generators, small engines, subassemblies, etc., can thus be shipped damage free. The reusable containers may be marked for purposes of identification, and packed in pallet form are easy to handle. Standard inner packs of various designs are available, and special ones will be engineered by the company upon request.

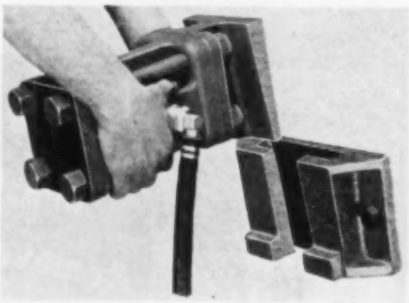
New solenoid single-plunger valves have been added by C. B. Hunt & Son, Inc., to its Quick-As-Wink line. Known as the Type "SA," it has a small solenoid which travels through a 1/8-inch stroke to move a small plunger on a pilot valve which, in turn, applies air to the operating piston to move the main-valve plunger. The design is said to insure positive performance and a much greater working force than is obtainable with a large direct-connected solenoid. Reduced amperage requirements permit operation with standard pilot switches, and because the solenoid plunger and pilot cylinder weigh only a few ounces and have a short travel the valves can function at high speeds on air pressures up to 200 psi. They are especially suitable for use with certain production welders and other high-cycle equipment. Housing and all internal parts, except the packing, are of brass or bronze. Plungers and pistons are of stainless steel.



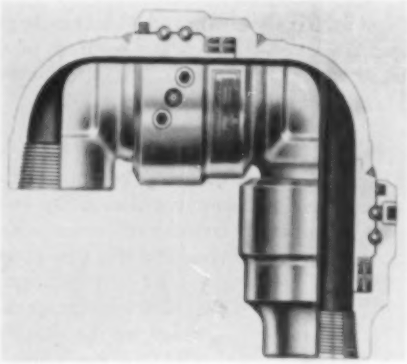
Rez-N-Cote is the name of a new synthetic lacquer that is said to make wood waterproof. Applied by brush or spray gun, it air dries in five minutes, or in one if exposed to infrared lamps or similar equipment. According to the Schwartz Chemical Company, Inc., maker of the product, the film remains flexible, is not affected by expansion or contraction of the wood, does not soften when submerged in water for extended periods, dries free of blush or haze, and may be cleaned with alkaline soap. The lacquer is available in clear form and in transparent or opaque colors.

What is described as a multipurpose compound for maintenance coating and production finishing has been announced under the name of Kem-Ban by Ace Laboratories. Based on a special copolymer as a binder and incorporating rubber derivatives as plasticizers, the material is said to be an effective rust inhibitor; to offer excellent resistance to acids, alkalies, chemical fumes, salts, and alcohols; to be a fire retardant; and to possess high dielectric strength—properties that make it suitable for protecting metals and nonmetals, including wood, linoleum, composition flooring, concrete, paper, rubber, and textiles, as well as for insulating and exterior finishing motors, controls, and other electric equipment. As a rust preventive it can be applied directly even to polished surfaces and serves as a primer for subsequent coats. It is put on by spraying, dipping, or brushing and is available in clear form and in a number of colors.

Intense vibration to speed the unloading of such materials as soda ash, cement, lime, carbon, coal, iron ore, and other materials shipped in bulk is induced by a new air-operated device offered by the Cleveland Vibrator Company. The assembly incorporates a cast-steel male and female wedge-type mounting bracket for attachment to hopper railroad cars, but is also recommended for use on other materials-handling equipment such as special hoppers, bins, chutes, flasks, and mining cars. Air consumption ranges from 30 to 36 cfm. at 80 psi. By means of a pressure regulator the speed of operation of the standard unit can be varied from 700 to 1100 vibrations per minute and of the heavy-duty models from 600 to 1000 per minute. Equipped with swivel-type air-intake connections, the vibrators can be moved from one application to another without hose kinking or twisting. They are available in standard 3-inch piston diameters and 3-inch heavy-duty long-stroke sizes.



Conveying fluids under high pressure through piping that rotates a full 360 degrees in all planes is the purpose of an improved ball-bearing swivel pipe coupling announced by Gil-Lair Products, Inc. The unit has no projection and is free from bolted flanges, threaded sleeves, locking rings, and keys. The rotating members are held together with two sets of ball-bearings operating in flame-hardened and ground ball races. A patented metal-backed packer assembly renders the coupling tight under all pressures from vacuum to 12,000 psi. It is made up of two packers each consisting of a T-shaped metal backer to which a pair of synthetic rubber lips are vulcanized and bonded. Each backer functions in its own chamber. High-pressure swivel pipe couplings are made of steel; those for low-pressure service are of aluminum, bronze, and malleable iron or steel. They are designed for an average speed of rotation not to exceed 60 rpm. and are available in a wide range of sizes and for working temperatures up to 225°F. The company is prepared to develop couplings for special industrial applications.

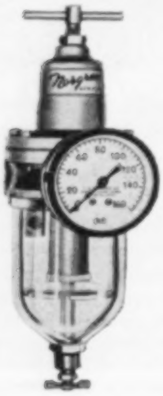


Several advantages over conventional bottom-opening skips for mine shafts are claimed for a new type designed by G. L. Saunders of Toronto, Canada. According to the latter, his skip travels only 5 feet 8 inches to dump its load, as compared with 27 feet in the case of present types of like capacity. Also, by saving headroom, it permits the use of a smaller headframe or larger surface ore bin.

Shown here is a new stacker in the Portelvator line made by the Hamilton Tool Company. With a carrying capacity of 1000 pounds the platform can be raised from a minimum of 6 inches above the floor to a maximum height of 58 inches. It locks automatically at any position throughout its range and cannot slip or settle under the load. Plat-

form is 26 inches wide and 24 inches deep and is moved through the medium of a hand crank, roller chain, meshing bevel gears, and screw.

Only 11 inches high, the new Norgren Filter-Regulator pictured combines filtering and pressure regulation in one compact unit. It is designed for use with air and any noncorrosive gas at pressures up to 125 psi. and at ambient temperatures up to 120°F. The filter has a directional inlet that gives the entering fluid a centrifugal force, throwing entrained moisture and solids against a transparent bowl, where they run down into a quiet zone beneath a baffle. Remaining solids are removed by a 200-mesh screen of reinforced monel wire. The separator has no moving parts and no cartridge to replace. The performance of the regulator is claimed to exceed that of types having larger diaphragms and valve ports. The entire unit is easily installed and dismantled without necessitating removal from the line and is recommended for service on production machines and spray-painting equipment, for instrument control, and for general industrial air-line use.



Accurate measurement of gas-flow rates can be made at low cost by the use of a new variable-area flowmeter known as the Floguide developed by the Fisher & Porter Company. Moving freely within a tapered precision-bore metering tube is a weight or float, both fabricated from stainless steel. The former is brazed to cast-iron inlet and outlet fittings, permitting simple panel installation. An extension below the tube carries a wide-angle, rotatable metering scale, and an indicator beneath the float permits direct reading of the flow rate. The Floguide is available in capacities ranging from 45 to 16,000 standard cubic feet of carbon dioxide per hour, 200 to 76,000 SCFH hydrogen, and in comparable capacities for other gases. Although primarily designed for low-pressure service, all sizes can be furnished to withstand a working pressure of 600 psi. Maximum operating temperature is limited by the properties of commercially available packings.

Quick reversibility of action is the feature of the new Foxboro Stabilflo air-operated control valve. In a few minutes, without the use of special tools, it can be changed from "air to open" to "air to close," or vice versa. It is not necessary to remove the valve from its installation or to shut down the controlled flow, the manufacturer says. To reverse the action of the valve motor all that is needed is to take out the housing assembly, rotate it one quarter turn, and put it back. This calls for the removal and replacement of but four bolts, which is done with a standard wrench.

Adhesive tape with the unbelievable tensile strength of 500 pounds per inch of width is now under production by the Minnesota Mining & Manufacturing Company and is to be distributed this spring. It has a backing of acetate film to which is applied a rubber adhesive in

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KEEP your expensive moisture removal equipment at top efficiency — automatically drain these vital units of the moisture they collect with low cost Armstrong Air Traps. Armstrong traps on separators, aftercoolers, etc., save you air, time and labor, eliminate human failure.

Ruggedly built, these units are available in three types, ball float, snap action or inverted bucket models to give you best service for a given condition.

Bulletin No. 1433 gives the details.

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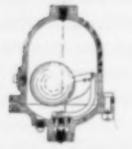
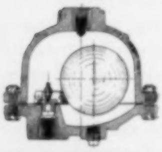
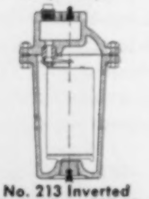


No. 71 Snap Action Trap $30.00



No. 21 Ball Float Trap $11.00



No. 213 Inverted Bucket Trap $20.75

ARMSTRONG *Air* TRAPS

which thousands of glass filaments are embedded parallel with the tape. These gossamer threads serve as a reinforcing, like steel rods in concrete. Designated as No. 890, it is being made in widths of ½, ¾, and 1 inch and is intended for strapping fiberboard cartons, steel coils, pipes, etc. Sample rolls can be obtained from the company at 900 Fauquier Street, St. Paul 6, Minn.

Public Service Company of New Hampshire is now operating what is claimed to be the most efficient electric generating station of its size. In this combination mercury vapor-steam plant of 40,000-kw. capacity, liquid mercury is vaporized by burning either pulverized coal or the lowest commercial grade of fuel oil and then passed through two 7500-kw. turbogenerators. The still hot vapor next goes to condenser-boilers, where its latent heat produces enough steam to drive a 25,000-kw. turbogenerator. Named the Schiller Station for Pres. Avery R. Schiller of the operating company, the plant will feed current into a transmission network that supplies power to most of New Hampshire. The generating equipment was built by General Electric Company.

SECOND-STORY SPRAY GUN

For painting overhead, the Eclipse Air Brush Company, of Newark, N. J., has introduced the extension spray gun pictured here at work on the hull of a ship. Extensions from 4 to 12 feet long are available, permitting paint to be applied to heights of 16 feet or more. A 6-foot extension weighs only 4 pounds. The guns, which are offered in three models, can handle any sprayable fluid from light paints to heavy asphaltic compounds.

Naylor Wedge-Lock Coupling Joins Naylor Light-weight Pipe To Do a Better Job for Mining Engineers

THE RIGHT COMBINATION FOR DEPENDABLE PIPE LINES

The Naylor one-piece, positive type Wedge-Lock Coupling slips over the grooved or shoulder ends on Naylor pipe to provide the fastest and easiest method yet devised for connecting pipe. A hammer is the only tool needed. Joints can be made up with only one side of the pipe in the open. Other advantages include tight, leakfree joints, less power loss, smoother operation, more consistent delivery, long service life and high re-use value. Add to this, the outstanding performance of Naylor light-weight pipe and you have a perfect combination for mining service. Pipe sizes 4" to 30" in diameter—thicknesses from 14 to 8 gauge. Write for Catalog No. 44.

NAYLOR PIPE COMPANY
1245 East 92nd Street, Chicago 19, Illinois
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"a vast improvement in production"

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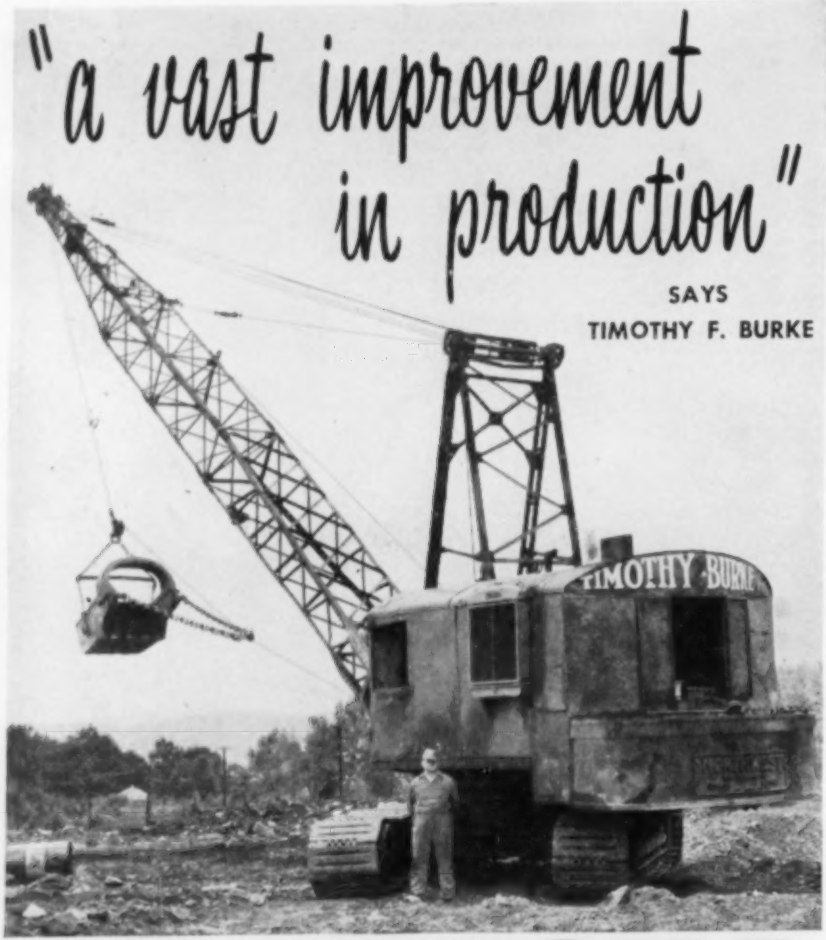
TIMOTHY F. BURKE

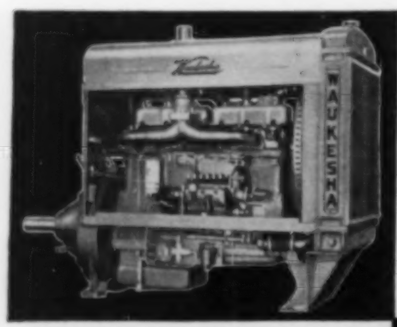


WAUKESHA Diesel POWER

● Timothy Burke, Inc., of Scranton, Pa., have been excavating engineers for 67 years—in railroad and dam construction—and, for the past 32 years, coal stripping in the Anthracite region. Right now they're operating eighteen shovels and draglines. With their experience, they *know* a good engine when it comes on the job . . .

Here's what their Mr. Timothy F. Burke, Vice-Pres. and Gen. Mgr., says: "We installed a Model 148-DKU Waukesha Engine in our Northwest Model 85 Dragline to replace a gas engine (of another make) and we are very pleased with the performance . . . We have noted a vast improvement in production, and with regards to efficiency and economy, we can say the results have been very satisfactory." Easy to start, too, these Waukesha Diesels, and smooth . . . snappily responsive to all power and load demands.

Auto Gear & Parts Company, Inc., of Philadelphia, conversion specialists, supplied this Waukesha Diesel and installed it. Ask your distributor about Waukesha Diesels. Send for Bulletin 1414.



Model 148-DKU WAUKESHA DIESEL—Six cylinders, 5¼-in. x 6-in., 779 cu. in. displacement, 180 hp. maximum.

WAUKESHA MOTOR COMPANY
WAUKESHA, WISCONSIN
NEW YORK • TULSA • LOS ANGELES

Industrial Literature

Changes in the flow rate of gases, liquids, or other fluids caused by variations in their pressure and temperature can automatically be compensated for by meters described and illustrated in Bulletin M-51 of Hagan Corporation, Pittsburgh 30, Pa. Of the ring-balance type, the meters have a built-in integrator that automatically totalizes the flow. Publication includes several diagrams, one indicating how a corrected record such as is continually produced compares with an uncorrected flow, and another showing a typical installation. A copy of the bulletin will be sent upon request.

Henry Vogt Machine Company, Inc., has brought out a booklet describing its Class VL water-tube boiler for industrial plants, institutions, and other services having varying steam requirements. It is designed so that it may be used under limited space conditions and still expose a large proportion of its surface to the furnace, as well as to insure proper combustion of fuels fired in suspension or by stokers. Specifications, operating data, and detailed drawings of a number of installations are contained in the booklet, a copy of which will be sent upon request to the company at 1000 West Ormsby Street, Louisville 10, Ky.

A leak detector for service where a specified vacuum, pressure, or other atmosphere must be maintained for extended periods is explained in a bulletin put out by Vacuum-Electronic Engineering Company, 316 Thirty-Seventh Street, Brooklyn 32, N. Y. Suitable for both laboratory and industrial use, the instrument is said to be so sensitive that it can detect a flow of less than 0.00001 standard cubic centimeter an hour. Applications include the testing of valves, electronic tubes, glass-to-metal seals, high-vacuum and high-pressure systems, welded tanks and vessels, heat exchangers, condensers, porosity of materials such as ceramics and metals, as well as distillation, refrigerating, air-conditioning, and chemical-process equipment.

Telemetering systems for electric-power distribution and other industrial applications are covered in Bulletin No. GEA-5233 of General Electric Company, Schenectady 5, N. Y. They are designed for measuring current, voltage, power, pressure, position, flow, or other electric and nonelectric quantities, transmitting the information to a remote location, and there recording it or actuating machinery for its control. May be operated mechanically, pneumatically, hydraulically, or electrically, depending upon the nature of the material and the distance and speed required for transmitting the measured variable. The bulletin gives specifications and other data about the telemeters, shows simple wiring diagrams of typical installations, and describes auxiliary equipment.

Designers of air and hydraulic circuits can obtain a chart giving valuable flow and pressure data by writing to Miller Motor Company, 4027 North Kedzie Avenue, Chicago 18, Ill. Information in the form of tables that eliminate laborious calculations are included. One gives both push- and pull-stroke pressures in pounds for various cylinder sizes and piston-rod diameters at pressures from 50 to 3000 psi., as well as the respective oil and air consumption of hydraulic and pneumatic cylinders ranging in bore diameter from 1½ to 20 inches. Another covers pipe sizes necessary for well-designed hydraulic circuits and indicates

---

Grade up your Punch Presses and Power Shears

WITH THIS New CLUTCH BRAKE

Our *Flex-Disc* Clutch, standard equipment for the past ten years on Ingersoll-Rand portable air compressors, has been adapted to punch presses and power shears. See photograph above of a 28 in. *Flex-Disc* double clutch—single brake on a No. 310 billet shear of United Engineering & Foundry Co., now in service at Keystone Steel & Wire Co., Peoria, Illinois.

Operating advantages of the *Flex-Disc* Clutch Brake include:

1. Air operation at shop line pressure through a push button operated electric solenoid valve.
2. Operating temperatures for continuous operation at ten cuts a minute do not exceed 140° F.
3. Total wear (by actual tests) on each friction facing per 100,000 starts and stops is only .002 in. This gives a life expectancy of clutch facings on the order of 6,250,000 cycles.
4. Replacement of worn clutch facings is quickly made without dismantling the clutch-brake assembly. See photograph at left of the interlocking *Flex-Disc* construction.

The *Flex-Disc* Clutch Brake is available in a complete range of sizes from 8¼ to 35" O.D., and torque capacities from 3660 to 578,000 lb/in.

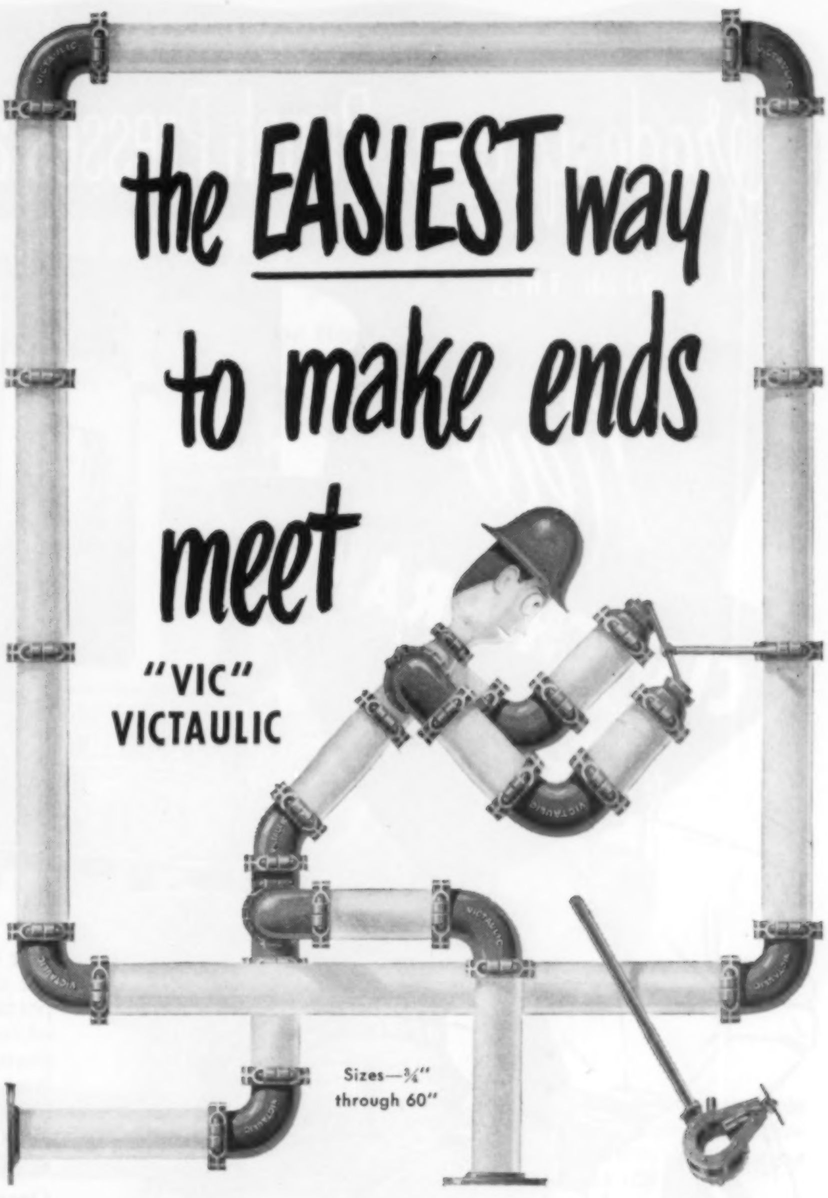
INDUSTRIAL CLUTCH CORPORATION
Waukesha Wisconsin

friction pressure losses for different pipe sizes and conditions of service, as well as for fittings and valves. In addition, the chart gives recommended piston-rod diameters for various loadings and mounting conditions, etc. It is available in a 3-color 22x34-inch wall chart and in an 8½x11-inch size perforated for insertion in ring binders.

For concerns who perform partial or complete assembling operations requiring the use of washers, Pheoll Manufacturing Company has a booklet covering lock-washer-and-screw assemblies. Each unit consists of a screw and of a lock washer held underneath the head by the rolled screw thread. Although free to rotate, the washer cannot slip or work out of position. The devices are said to reduce assembly time. Screws illustrated and described include round-, pan-, truss-, fillister-, flat-, and oval-head styles in both slotted and Phillips recessed-head construction. Plain, indented, and slotted hexagon-head types also are available. Lock washers covered include external, internal, countersunk, spring, flat-metal, flat-metal-and-spring, dome, fiber, and heavy-duty for both standard and special assemblies. The bulletin includes information on special kinds of plating, heat-treating, etc. A copy of Catalogue No. 80-A can be obtained from the company, 5700 Roosevelt Road, Chicago 50, Ill.

Industrial vacuum hose made by B. F. Goodrich Company, Akron, Ohio, is the subject of Bulletin 4780 obtainable upon written request. The line includes many types and sizes such as heavy-duty hose for vacuum-cleaning in public buildings and institutions; a standard, lighter-weight type for portable vacuum cleaners or to serve as a breather line to deliver pure air to helmets worn by men operating in contaminated atmospheres; hose from 2 to 12 inches in inside diameter that may be used with either vacuum or low-pressure air to collect and convey dust, abrasive particles, scrap materials, ground cork, grains, etc.; and an exhaust hose of the same size range for removing toxic or corrosive fumes from working areas, for carrying large volumes of air at normal, warm, or refrigerated temperatures, and for collecting nonabrasive materials. Also obtainable from the company is Bulletin 9780 which describes pipes, fittings, and valves lined with rubber of varying composition to handle chemicals, semisolids, and suspensions.

How foundries and other industries that require large volumes of air for ventilating purposes can heat the incoming air during cold weather effectively and economically is told in Bulletin 520 of Dravo Corporation. According to the company, exhausting huge quantities of air from a closed building without replacing it with clean, fresh, "heat-tempered" air results in lower atmospheric pressure inside the structure that hampers the functioning of exhaust fans, leads to inefficiency in the case of ovens and other process equipment by upsetting the combustion balance, and may cause increased wear of machinery through concentrations of abrasive or corrosive dust in the atmosphere. The booklet describes how industrial heaters, made by the firm, draw in cold air from the outside, heat it to the desired temperature, and then distribute it throughout the working area. The units, which can be fired by oil or gas or fitted with combination burners to take either fuel, can also be used for comfort space heating, for year-round ventilation, for process drying, and for heat curing. A copy of the bulletin can be obtained by writing to the company at Fifth and Liberty Avenues, Pittsburgh 22, Pa.



Even on the toughest piping jobs VICTAULIC Couplings, Victaulic Full-Flow Elbows, Tees and other Fittings will make joining those pipe ends quick, easy, and economical – assure you a leak-tight piping job!

You save every way when you *join up* with "Vic"– a simple two-bolt design gives quick, easy hookups, a standard T-Wrench is the only tool needed for connections . . . joints are positive-locked, leak-proof, will stand up under extreme pressure, vacuum, or strain conditions.

GROOVING THOSE PIPE ENDS is a cinch the Victaulic Way . . . "Vic-Groover" grooves 'em automatically in half the time of a conventional pipe threader!

The COMPLETE Victaulic Line *can't be beat* for efficient, dependable, on-the-job piping construction. Yes Sir! Victaulic IS the Easiest Way to Make Ends Meet. JOIN UP WITH "VIC"– make your next piping job ALL VICTAULIC. Write today for these two:

Victaulic Catalog and Engineering Manual No. 44. "Vic-Groover" Catalog No. VG-47.

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26TH VICTAULIC YEAR

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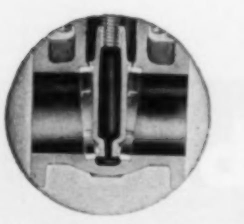
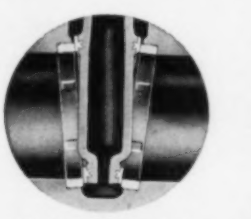
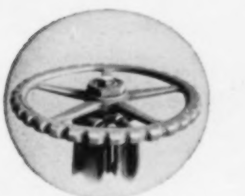
VICTAULIC
PIPE COUPLINGS AND FITTINGS



Straight-Flow Port Design reduces fluid turbulence to a practical minimum.



Seat Rings of end-seated type are screwed into the body.



Sure-Grip Malleable Handwheel for non-skid gripping even with heavy gloves.

WALWORTH

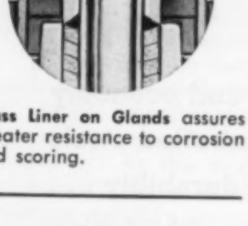
iron body gate valves

with screwed or flanged ends

6
WALWORTH
6
125 WSP
200 WOG
WALWORTH
6
WALWORTH
6
125 WSP
200 WOG
WALWORTH

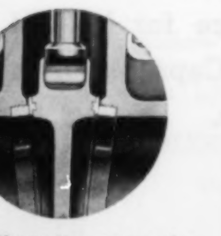
... 8 Outstanding Features

For complete information on these new Walworth Iron Body Valves, see your local Walworth distributor, or write for bulletin 106.

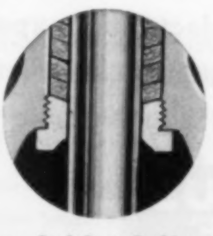


Brass Liner on Glands assures greater resistance to corrosion and scoring.

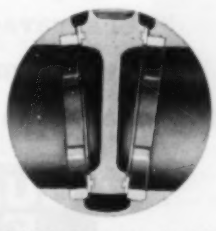
WALWORTH
valves and fittings
60 EAST 42nd STREET NEW YORK 17, N. Y.
DISTRIBUTORS IN PRINCIPAL CENTERS THROUGHOUT THE WORLD



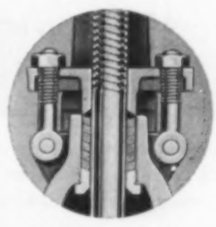
T-head Disc-to-Stem connection on OS&Y types provides stronger connection, prevents loosening of disc by corrosion.



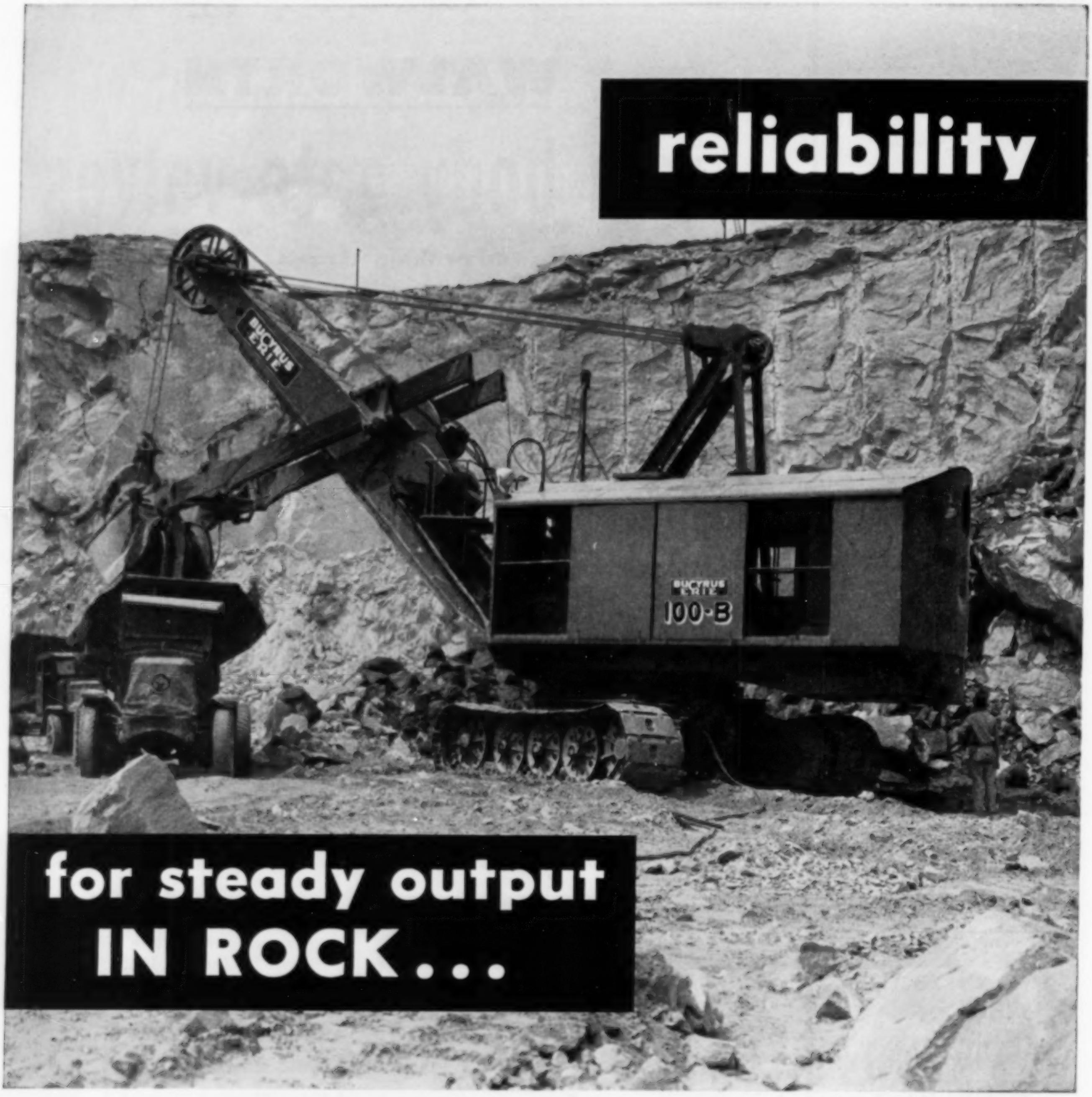
Bronze Back-Seat Bushings in bonnets of OS&Y valves.



Solid Web Type Disc in OS&Y valves for greater strength and longer service.



Hinged Gland Eye-Bolts on OS&Y valves permit faster, easier repacking under full pressure.

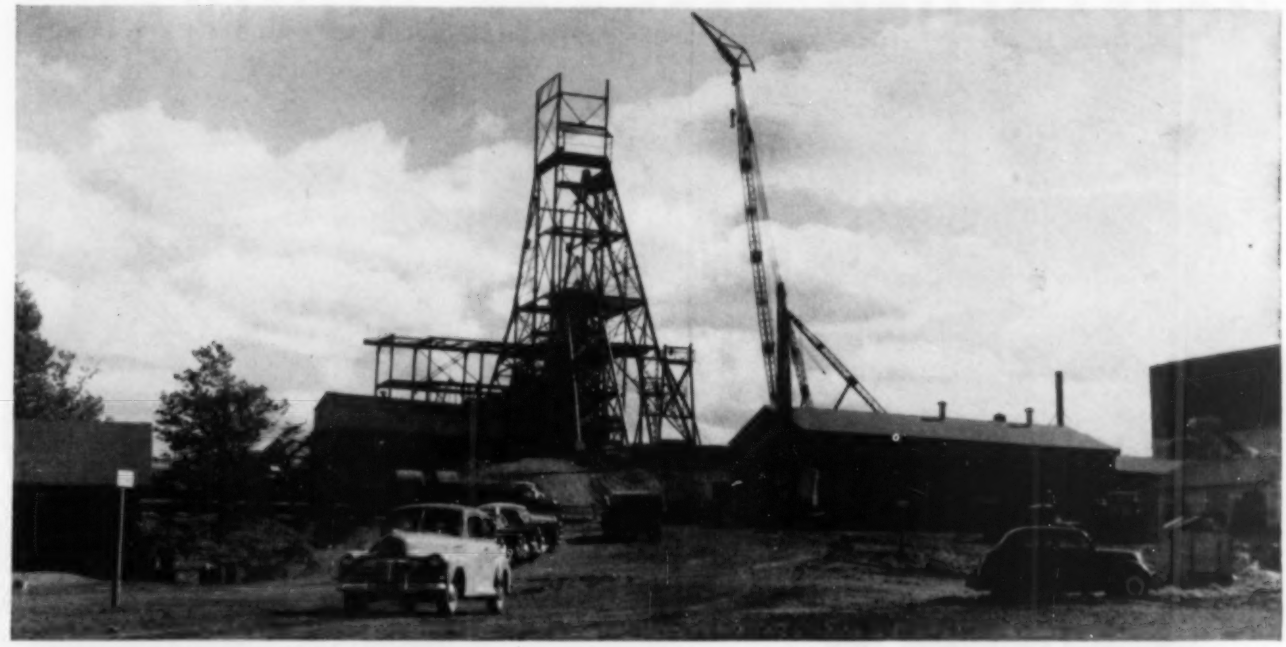

reliability
for steady output
IN ROCK...
BUCYRUS ERIE
BUCYRUS ERIE
100-B

Because they stay on the job for sustained high output year after year, more Bucyrus-Erie shovels are chosen for tough quarry and mining work than any other make of excavator. Their dependability comes from *years ahead* design for speed, capacity, low maintenance and economy . . . from laboratory-controlled steels for great strength and durability . . . from Bucyrus-Erie's unmatched manufacturing experience for highest quality construction. Capacities from 2½ to 36 cubic yards.

BUCYRUS ERIE

SOUTH MILWAUKEE, WISCONSIN

79L49



Steel headframe of the Mather B Shaft during construction. This project was directed by C. J. Stakel, General Manager of Cleveland-Cliffs Iron Co. at Ishpeming, Mich., and J. S. Westwater, Superintendent of the Mather B Shaft at Negaunee, Mich.

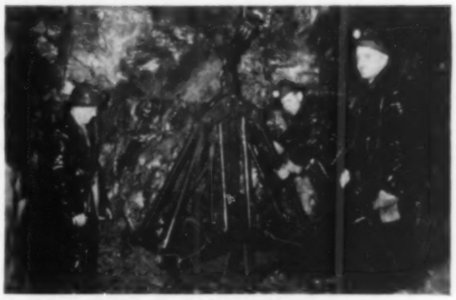
Mather B Shaft Sinking Speeded by Modern Mucking and Drilling Methods

The recently-completed Mather B Shaft at the Mather mine of Cleveland-Cliffs Iron Co., Negaunee, Mich., has attracted wide interest because of the unique "Hydro-Mucker", a hydraulically-operated clamshell bucket, which was developed by some imaginative engineering on the job to speed up mucking operations. Detachable bits tipped with tungsten carbide also received a large share of credit for the rapid progress. These bits, used on rods of Bethlehem Hollow Drill Steel, gnawed through the hard, blue jasper and other abrasive rock in record time.

Sunk vertically to a depth of approximately 3100 ft, this steel- and concrete-lined shaft measures approximately 15 by 20 ft and is divided into four compartments for handling ore, men and supply piping. It is a companion to the 2352-ft Mather A Shaft, completed early in 1943. Both facilitate the orderly development and mining of ore on this Marquette Iron Range property.

Following the removal of overburden and installation of equipment above ground, the shaft work really got under way on October 21, 1947. Speed being such a predominant factor in shaft-sinking operations, every resource was explored to attain the greatest possible efficiency. As the shaft was sunk deeper, the advance per month increased despite the longer travel time in hoisting operations. The average monthly advance of 137 ft during 1948 was exceeded during 1949 when a monthly average of 159 ft was attained during the first 7 months.

Bethlehem Hollow Drill Steel in 1-in. quarter-octagon size was used exclusively from start to finish, putting down approximately 224,000 ft of 1½-in. holes.



View showing the "Hydro-mucker" cleaning up shaft bottom at depth of approximately 3000 ft. This bucket stepped up muck removal to 12 cu yd per hour, even when hoisting depths exceeded 2500 ft.

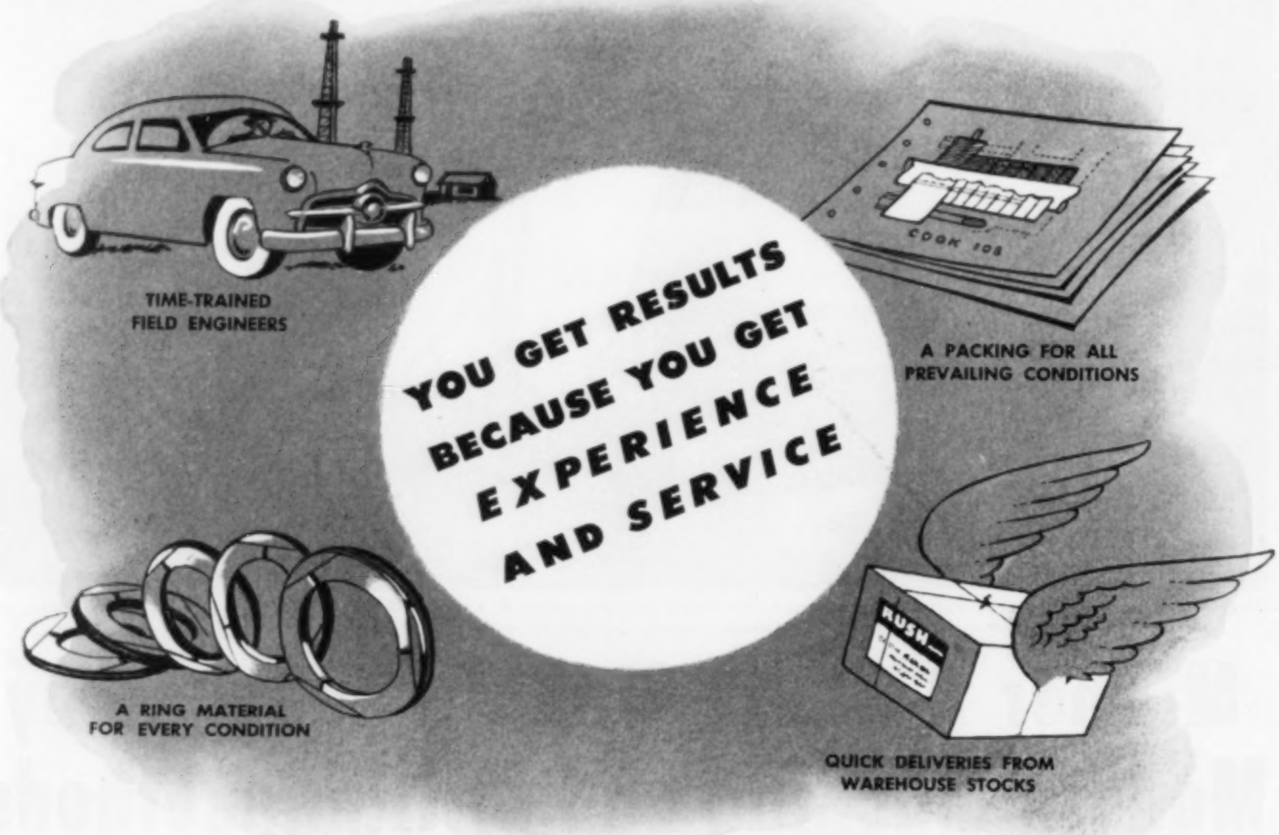
Mounted on a pneumatic column, this drifter drill was used to "cut out" on the tenth level, about 3012 ft below the collar of the vertical, 3100-ft shaft.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by
Bethlehem Pacific Coast Steel Corporation
Export Distributor: Bethlehem Steel Export Corporation

BETHLEHEM HOLLOW DRILL STEEL


TIME-TRAINED FIELD ENGINEERS
COOK 108
A PACKING FOR ALL PREVAILING CONDITIONS
YOU GET RESULTS BECAUSE YOU GET EXPERIENCE AND SERVICE
A RING MATERIAL FOR EVERY CONDITION
RUSH
QUICK DELIVERIES FROM WAREHOUSE STOCKS

Your compressors that come equipped with Cook Packings are engineered to provide long periods of economical and uninterrupted operation. The packings, too, are engineered to give the same type of service. But even the most perfect packing ever built may develop trouble during initial operation if the gas conditions are not as originally represented or if pipe scale or line dirt are present in great quantities.

Such troubles are generally of a temporary nature. Even so, it would be wise to call in one of Cook's Field Service Men. With a background of many years of practical experience he can quickly analyze your problem and usually correct it in short order. Take advantage of this service. There is no charge. It can save you time and dollars.

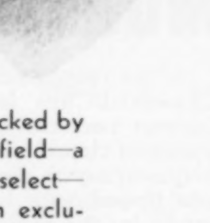
Keep in mind that Cook Packings are designed and built to render years of satisfactory service. Eventually, when you do require repair parts, be sure to get the genuine, backed by years of engineering service in the field—a wide range of designs from which to select—proven ring materials, many of them exclusive, for all operating conditions—and warehouse stocks in Louisville, Mid-Continent and California territories from which emergency shipments can be made in matter of hours.

For quick results, phone the nearest Cook office.

C. Lee Cook Mfg. Co. Louisville, Kentucky. Branch Offices in Baltimore, Boston, Chicago, Cleveland, Houston, Los Angeles, Mobile, New Orleans, New York, San Francisco, Tulsa.

COOK

ROD PACKINGS



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*MAXIMUM PROCESS UTILIZATION

with
MADISON-KIPP
Zinc and Aluminum
DIE CASTINGS

STEEL INSERTS

Product engineers may find a helpful suggestion from the die casting application illustrated. The aluminum body is an important part in the MADISON-KIPP lubricator pumping unit. The lightness, accuracy and strength of the die casting and wear resistance qualities of the inserted barrel sleeves provide maximum efficiency in an instrument used universally on machine tools, work engines and compressors. Cast-in iron, steel and brass inserts are anchored for life due to the shrinkage action of the molten metal around them and they may solve some of your design problems.

Please send your inquiries to our home office in Madison, Wisconsin.

The Model 50
Madison-Kipp Lubricator

MADISON-KIPP CORPORATION

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ANCIENS ATELIERS GASQUY, 31 Rue du Marais, Brussels, Belgium, sole agents for Belgium, Holland, France, and Switzerland.

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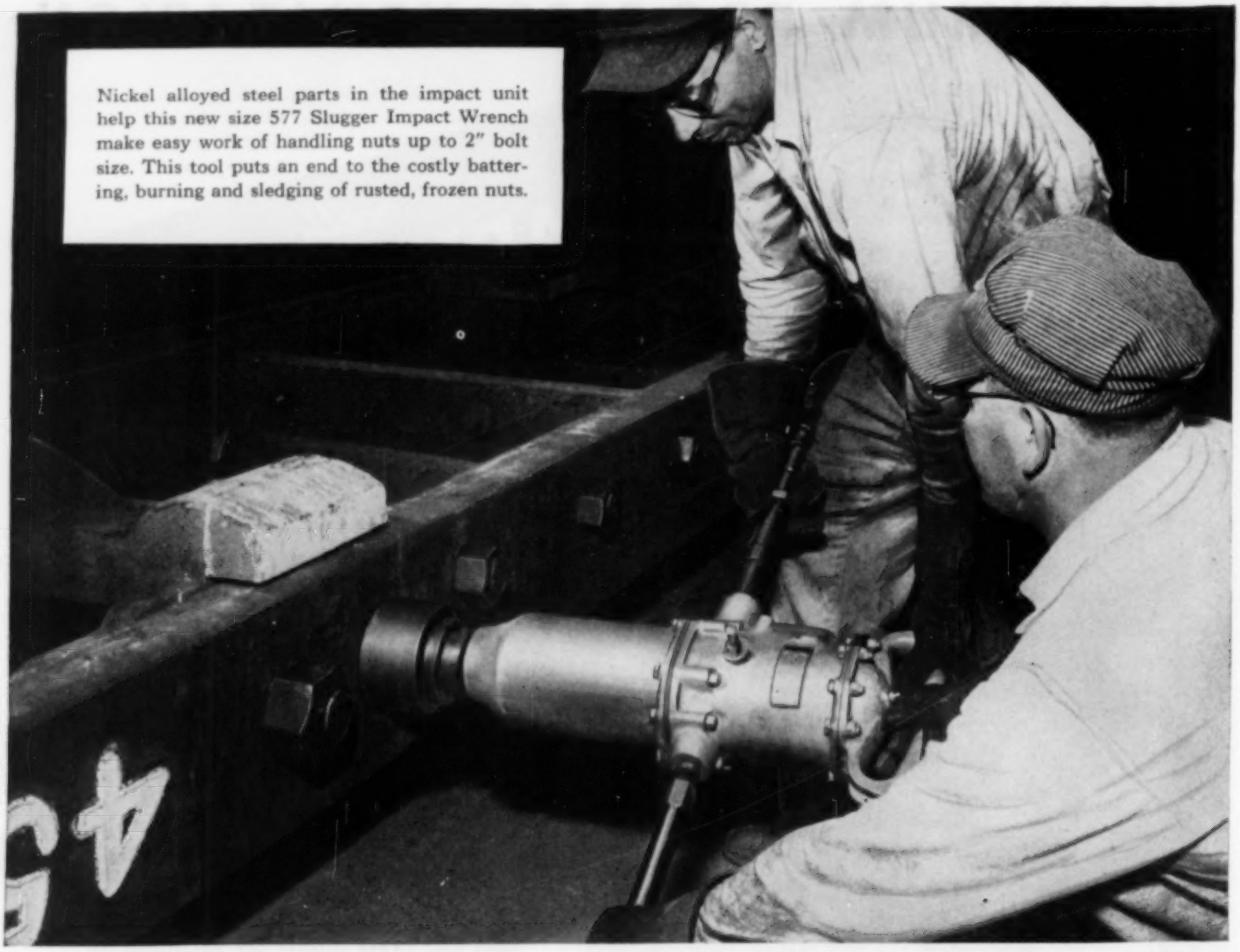


Nickel alloyed steel parts in the impact unit help this new size 577 Slugger Impact Wrench make easy work of handling nuts up to 2" bolt size. This tool puts an end to the costly battering, burning and sledging of rusted, frozen nuts.

NICKEL ALLOY STEELS help Impactools

Slug 'em on... Slug 'em off...

Here's a tool for both maintenance and production in heavy industry... it's the new Size 577 Impact Wrench, produced by Ingersoll-Rand Company to save time and effort in applying or removing large nuts, bolts and studs.

When its spindle meets resistance, thousands of rotary impacts per minute push through the job...

The hammer, anvil, arbor and all other vital parts of the impact unit withstand continuous terrific pounding and shock loads... without deforming or cracking ... because they are made from nickel alloyed steels.

These nickel alloyed steels meet exacting demands for high strength, toughness and wear resistance.

When you need a metal with extra qualities for dependable performance, less maintenance and fewer replacements, think of nickel alloyed steels. Send us details of your problems for our suggestions.

EMBLEM OF INCO SERVICE

Over the years, International Nickel has accumulated a fund of useful information on the properties, treatment, fabrication and performance of engineering alloy steels, stainless steels, cast irons, brasses, bronzes, nickel silver, cupro-nickel and other alloys containing nickel. This information is yours for the asking. Write for "List A" of available publications.

THE INTERNATIONAL NICKEL COMPANY, INC. 67 WALL STREET
NEW YORK 5, N. Y.

The ABC's of Powell Valve PERFORMANCE

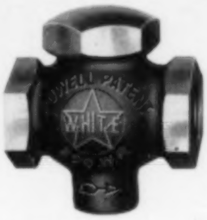


Fig. 95—Bronze Dash Pot Check Valve for 200 pounds air working pressure. Designed for air compressor service. Has screwed ends, screwed-on cap and regrindable, renewable, wear-resisting bronze disc. Cushioning effect of plunger in dash pot makes seating of disc practically noiseless.

Always the right valve. And, because Powell *can* always furnish the *right* valve, you can avoid failures that result from trying to make a valve "do" in a service to which it is not *specifically* adapted, as well as those caused by misapplication.

Built to last. Powell Valves are designed for long life at a minimum cost of maintenance. The cost of construction and materials of any Powell Valve is determined solely by the requirements of the service for which the valve is designed.

Complete Line. Powell Valves are made in all types such as Globe, Angle, "Y", Gate, Check, Non-return and Flush Bottom Tank. Materials include not only Bronze, Iron and Steel but also a wide range of Corrosion-Resistant metals and alloys.

Ask your nearest Distributor—or write direct

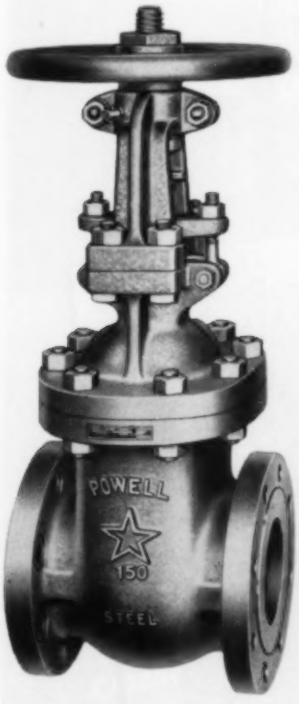


Fig. 1503 — Class 150-pound Cast Steel Gate Valve with flanged ends, outside screw rising stem, bolted flanged yoke, tapered solid wedge.

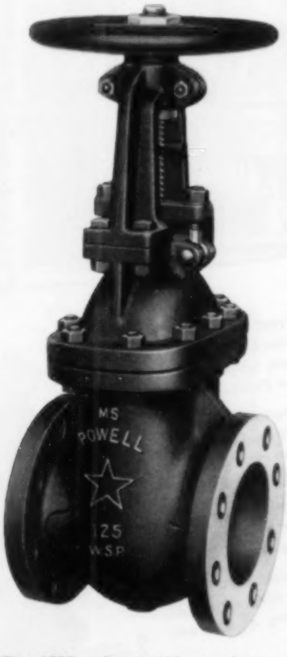


Fig. 1793 — Large 125-pound Iron Body Bronze Mounted Gate Valve. Made in sizes 2" to 30", inclusive. Has outside screw rising stem, bolted flanged yoke and tapered solid wedge.

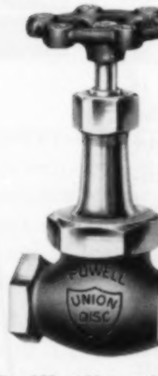


Fig. 150—150-pound Bronze Globe Valve with screwed ends, union bonnet and renewable composition disc.

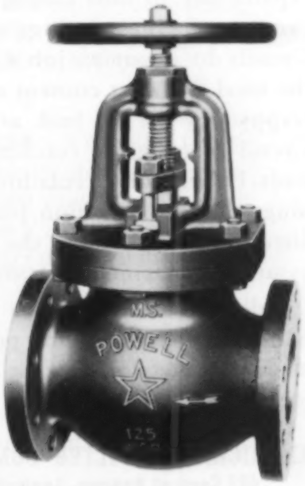
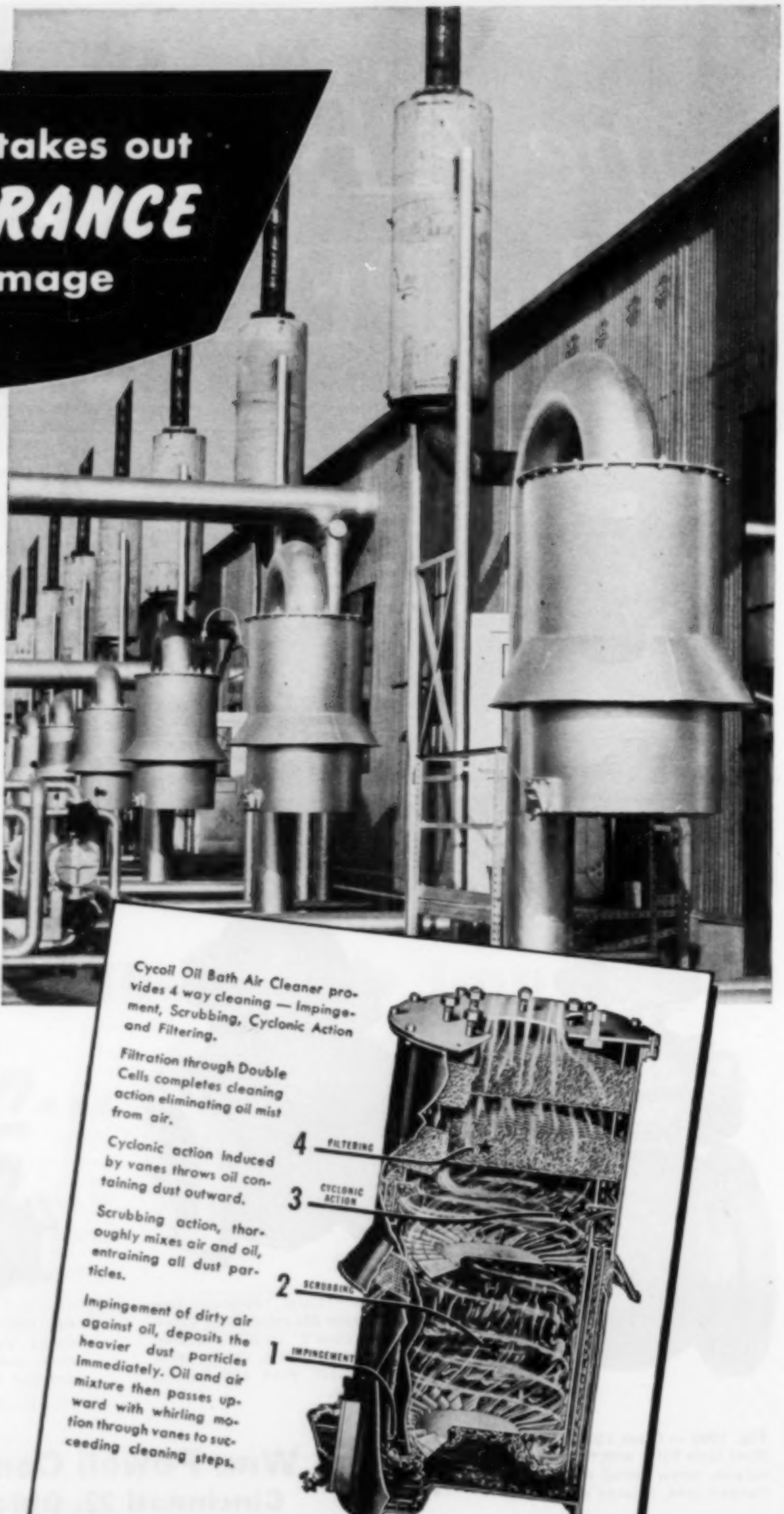


Fig. 301 — 125-pound Iron Body Bronze Mounted Globe Valve. Has flanged ends, bolted flanged yoke, outside screw stem, renewable bronze seat and disc holder with renewable composition disc.

The Wm. Powell Company
Cincinnati 22, Ohio
DISTRIBUTORS AND STOCKS IN ALL PRINCIPAL CITIES

POWELL VALVES

Warren Petroleum takes out *CYCOIL INSURANCE* against dust damage



Cycoil Oil Bath Air Cleaner provides 4 way cleaning — Impingement, Scrubbing, Cyclonic Action and Filtering.

Filtration through Double Cells completes cleaning action eliminating oil mist from air.

Cyclonic action induced by vanes throws oil containing dust outward.

Scrubbing action, thoroughly mixes air and oil, entraining all dust particles.

Impingement of dirty air against oil, deposits the heavier dust particles immediately. Oil and air mixture then passes upward with whirling motion through vanes to succeeding cleaning steps.

Engines at new Maysville, Antioch and Lindsay, Okla. plants equipped with this proven oil bath air cleaner.

THE recently completed Field Processing operation of Warren Petroleum Corporation and associates actually consists of three plants at Maysville, Antioch and Lindsay, Okla. At each location, Cycoils* are on the job. Pictured here are those units installed at Antioch for the protection of twelve 600 H.P. engines.

Cycoil insurance pays off in the form of dollars you *won't* spend for engine repairs due to dust damage. And you can count on these savings, too, because Cycoils do a *complete* job. Over 90% of the total fine dust content of the air is trapped by the oil bath action of the Cycoil even before reaching the filter pads. Positive oil circulation for continuing self-cleaning action, plus the added filtration to be had in the filter pads, assures approximately 100% clean air.

Bulletin 130-D tells you why Cycoil has set the standard for positive, permanent protection against dust. Write for your copy today.

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AAF®

Cycoil OIL BATH AIR CLEANER

AND INTAKE SILENCER

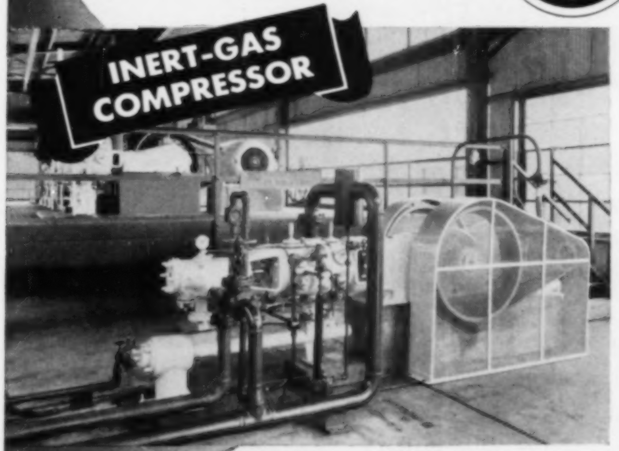
Compressors HELP PRODUCE HYDROGEN CYANIDE *at new ROHM & HAAS plant*

PROCESS-GAS COMPRESSORS

At its Deer Park Chemical Plant in Texas, the Rohm & Haas Company produces hydrogen cyanide on a large scale from ammonia, air, and natural gas as raw materials. The chemical products of Deer Park are shipped to other plants for making Plexiglas sheet plastics, coatings for leather, finishes for textiles, and adhesives.

In this Hypersorption process demanding the maximum in dependability, safety, and flexibility of control there are several types of Ingersoll-Rand compressors and four large I-R circulating pumps.

PROCESS-GAS COMPRESSORS...300-hp gas-engine-driven compressors handle the process gas from a regenerating unit. These are of Ingersoll-Rand 4-cycle, V-angle design, famous for economy of operation and maintenance, reliability, and flexibility for loading and control. (This type of I-R compressor is available in sizes from 100 to 1320 hp).



INERT-GAS COMPRESSOR...This 50-hp belt-driven, two-stage, ES heavy-duty unit compresses an inert gas to 200 psig pressure. The gas is held in storage as a safety measure in case of leakage of the chemical products, and for purging of lines.

AIR COMPRESSOR

AIR COMPRESSOR... This 125-hp, 2-stage, belt-driven Type XCB compressor generates 100-psig Air Power for instrument control and miscellaneous uses around the plant.

Call on Ingersoll-Rand when you need compressors for chemical or petroleum processes. There is a complete line of sizes and types for every purpose, and a representative near you.

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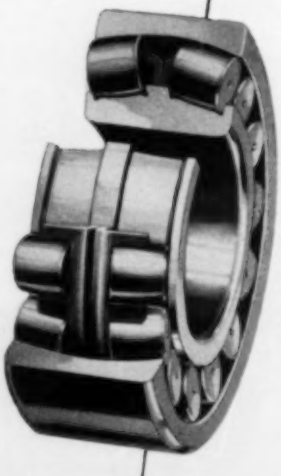
COMPRESSORS · AIR TOOLS · ROCK DRILLS · TURBO BLOWERS · CONDENSERS · CENTRIFUGAL PUMPS · OIL AND GAS ENGINES

NEVER TOO MUCH . . . NEVER TOO LITTLE
BUT **ALWAYS** JUST RIGHT

because of
TOLERANCE CONTROL

Another reason why industry prefers **SKF**

Remember leapfrog? How you used to have to skim over just right? Well, it's very much the same thing in specifying bearings. You don't want tolerances too great . . . and you don't want tolerances closer than the job demands. But you want to be sure that tolerances are *right* . . . are *always* properly controlled . . . *always* meet established standards. SKF adheres rigidly to these standards. Ceaseless vigilance in every stage of production assures complete control of tolerance throughout the entire manufacturing cycle. You can always be sure that any SKF Bearing will exactly meet your requirements . . . and will meet them again and again. Never forget, either, that *tolerance control* is only *one* reason why SKF Bearings will help you build equipment which, through smooth, economical performance, helps develop greater acceptance for your product. **SKF** Industries, Inc., Philadelphia 32, Pa.



SKF
Ball and Roller Bearings

8 REASONS WHY **SKF** IS PREFERRED BY ALL INDUSTRY

INTEGRITY · CRAFTSMANSHIP · METALLURGY · SURFACE FINISH · PRODUCT UNIFORMITY · ENGINEERING SERVICE · FIELD SERVICE

Inventors and Pioneers of the Self-Aligning Ball Bearing and Spherical Roller Bearing

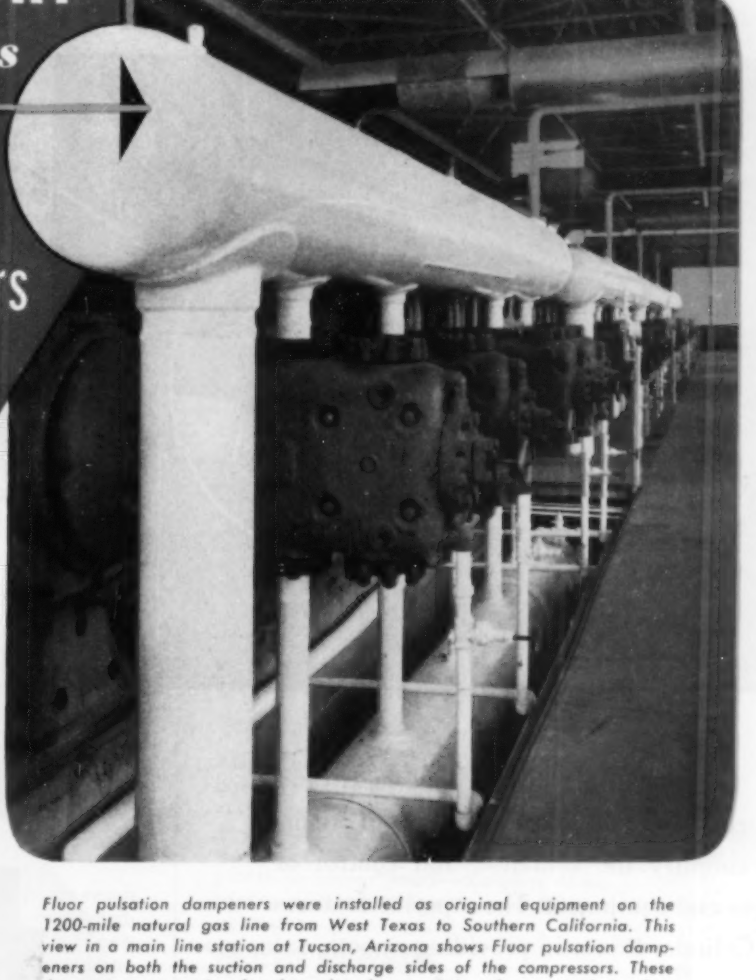
7050

1 cure · 2 prevent

pipe-line quivers with

FLUOR

Pulsation Dampeners



Pipe vibration from
gas-compressor pulses costs
money—in repairs, in
power consumption, and
in meter inaccuracy.
It can also cost Human Life.

1 cure

Where pulsative gas flow is already setting up destructive vibrations and instrument irregularities, Fluor pulsation dampeners can be installed as a complete remedy.

Fluor pulsation dampeners were installed as original equipment on the 1200-mile natural gas line from West Texas to Southern California. This view in a main line station at Tucson, Arizona shows Fluor pulsation dampeners on both the suction and discharge sides of the compressors. These dampeners are paying for themselves by permitting the required gas flow to be maintained with minimum horsepower.

2 prevent

On new installations, wherever there is danger of pulsation, you can safeguard compressor efficiency, reduce operating costs, and avoid headaches in general with proper pulsation-dampening units. You ***save*** money by buying Fluor pulsation dampeners to ***remove*** pulses instead of buying oversize pipes with necessary anchorages to ***resist*** them.

BE SURE WITH FLUOR

FLUOR

THE FLUOR CORPORATION, LTD.
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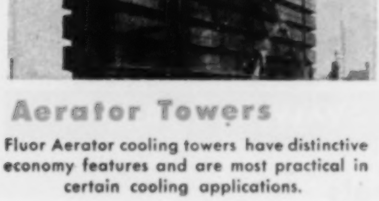


Aerator Towers

Fluor Aerator cooling towers have distinctive economy features and are most practical in certain cooling applications.

Counterflo Towers

Fluor Counterflo induced-draft cooling towers are a standard of industry for most water-cooling applications. They deliver "colder water cheaper."

Fin • Fan Units

Fluor air-cooled heat exchangers are more economical where make-up water is expensive, where water has bad scaling characteristics, and where the temperature of liquid to be cooled is relatively high. (Manufactured and sold by Fluor and Griscom-Russell Co.)

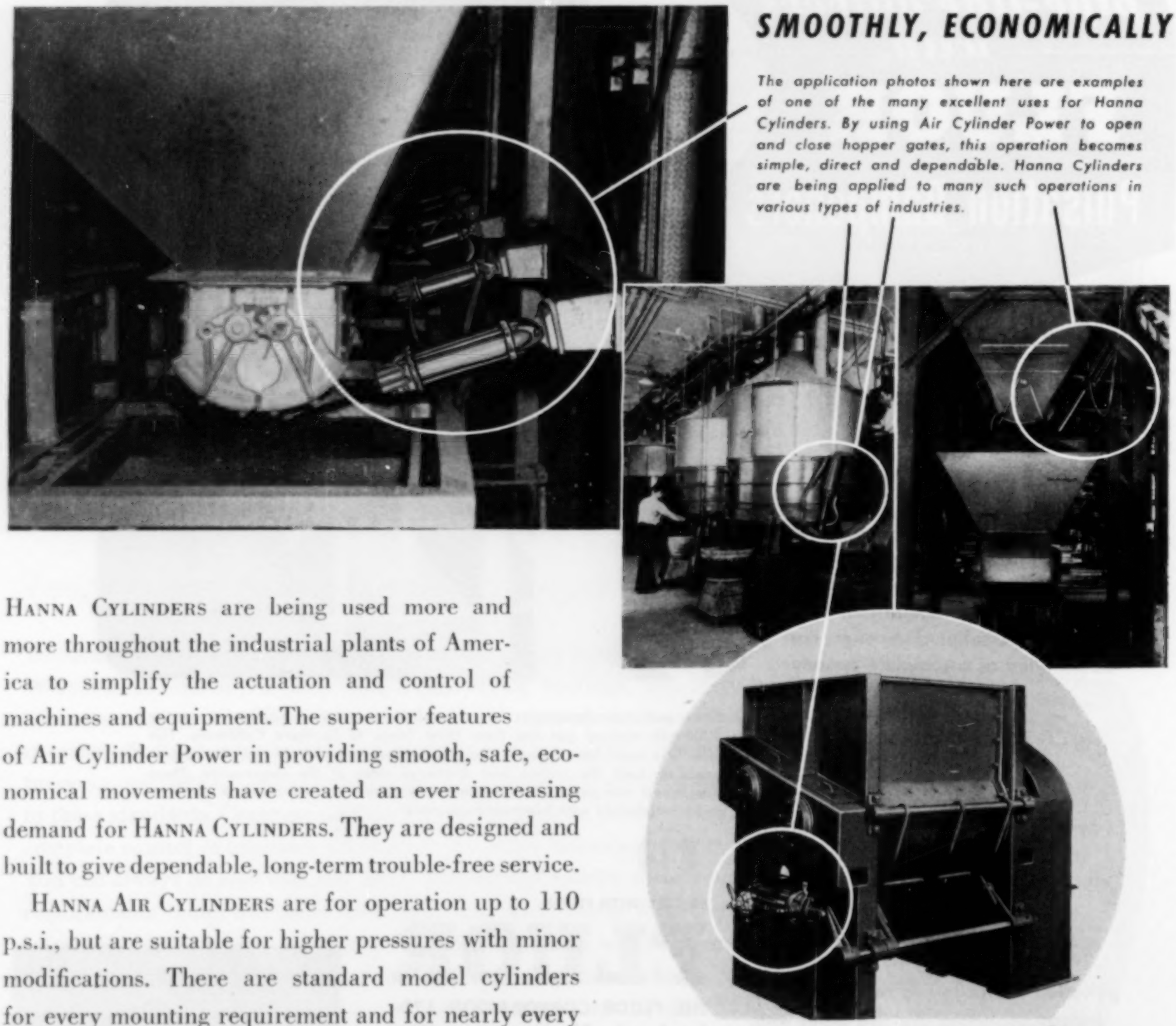
Another of their 1001 uses . . .

Hanna *Air* Cylinders

OPEN AND CLOSE HOPPER GATES

SMOOTHLY, ECONOMICALLY

The application photos shown here are examples of one of the many excellent uses for Hanna Cylinders. By using Air Cylinder Power to open and close hopper gates, this operation becomes simple, direct and dependable. Hanna Cylinders are being applied to many such operations in various types of industries.



Hanna Cylinders are being used more and more throughout the industrial plants of America to simplify the actuation and control of machines and equipment. The superior features of Air Cylinder Power in providing smooth, safe, economical movements have created an ever increasing demand for Hanna Cylinders. They are designed and built to give dependable, long-term trouble-free service.

Hanna Air Cylinders are for operation up to 110 p.s.i., but are suitable for higher pressures with minor modifications. There are standard model cylinders for every mounting requirement and for nearly every type application. Where can you use Air Cylinder Power to your advantage?

Send for Catalog

New Hanna Catalog No. 236 has 20 pages of facts and figures on Low Pressure Cylinders.

Hanna Cylinders

Hanna Engineering Works

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. . . for industry the world over!

Blaw-Knox engineering thinking and engineered products play important parts in world-wide industrial development. They fit into the picture wherever there is a chemical or processing plant to be planned or built, a highway or airfield to be constructed, ferrous or non-ferrous metal to be rolled and fabricated . . . wherever there is need for power and radio transmission. Blaw-Knox has the engineering brains, the manufacturing facilities and the organization to aid in getting plants into operation quickly, save man-power, increase production and reduce costs. Make this aid available to you by addressing Blaw-Knox Export Department.

Fifty-ton Soybean Oil Extraction Plant designed and erected by Blaw-Knox

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For concrete construction—Bins, batching plants, truck mixer loading plants, and central mixing plants are offered in many sizes and variations for both fixed and portable installations.

CLAMSHELL BUCKETS

Blaw-Knox builds the largest and most complete line of clamshell buckets made in America. A size and type for every need.

SUBGRADER, SPREADER, FINISHER

For concrete roads and airports—These three machines work as a team giving final preparation to the road bed, spreading the concrete evenly and finishing the surface.

TRUKMIXERS

The Blaw-Knox Trukmixer is the result of years of study. It excels in high yardage production and trouble-free performance. The revolving hopper eliminates many costly delays often caused by wear, leakage and seal failures.

ADNUN BLACK TOP PAVER

For bituminous roads and airports. This is the only machine of its kind that accurately lays hot or cold asphaltic mixes, sand, cinder, slag, soil, cement, chips and stone.

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Large 34 E Duomix double-drum model delivers 34 cu. ft. of mix every 35 seconds. 27 E and 34 E Single Mix have same strong, simple construction. Anyone who drives a truck can handle these big, fast mixers.

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Blaw-Knox supplies rolling mills and rolling mill equipment to the steel, aluminum and other non-ferrous industries.

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Blaw-Knox furnishes rolls for rolling mills in both iron and steel alloys for ferrous and non-ferrous metals, formulated and machined to the most exacting specifications for individual mills.

COMPLETE PROCESS PLANTS

Blaw-Knox engineers and technologists covering every major engineering field, and Blaw-Knox construction forces have an enviable reputation earned in building many of the newest and largest process plants in recent years—complete from process determination to commercial operation.

PROCESS EQUIPMENT

The design and fabrication of unusual and outstanding process equipment for modern industries, is a major Blaw-Knox activity.

OPEN STEEL FLOORING

Blaw-Knox grating for floors and stairs in factories, power plants, and similar uses, is famous for its safety, durability and easy maintenance.

INDUSTRIAL BUILDINGS

Blaw-Knox steel industrial buildings are quickly and easily erected, of permanent construction, inexpensive to maintain, and can be given insulation and exterior or interior treatment to fit the needs of the owner.

BLAW-KNOX COMPANY
PITTSBURGH, PENNSYLVANIA, U. S. A.

ADDRESS . . . EXPORT DEPARTMENT
SECTION 2047 CANADIAN PACIFIC BLDG., 342 MADISON AVENUE
NEW YORK 17, N. Y. • Cable Address: Blawknox, N. Y.

Here, the best tools and skilled operators produce

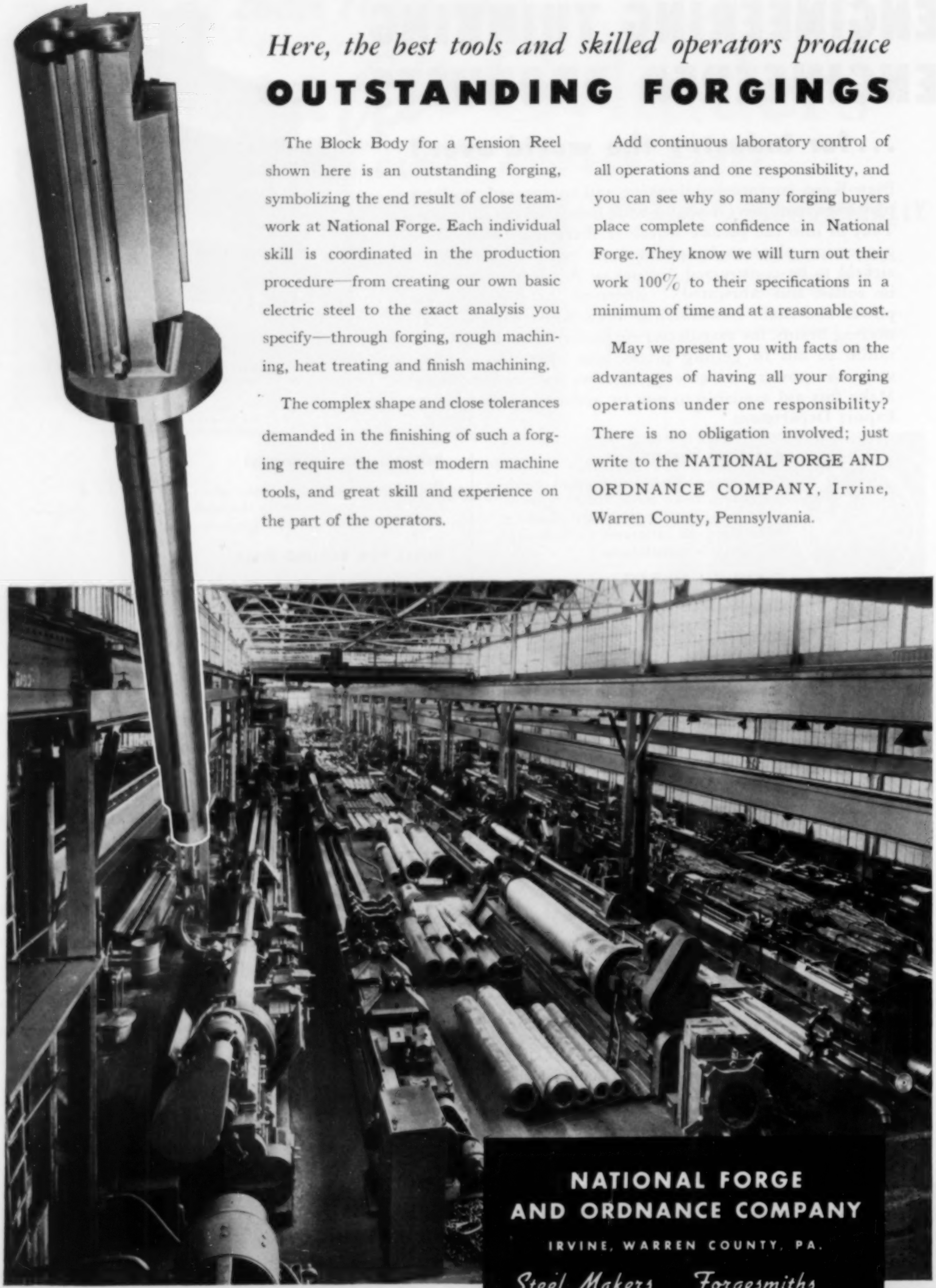
OUTSTANDING FORGINGS

The Block Body for a Tension Reel shown here is an outstanding forging, symbolizing the end result of close teamwork at National Forge. Each individual skill is coordinated in the production procedure—from creating our own basic electric steel to the exact analysis you specify—through forging, rough machining, heat treating and finish machining.

The complex shape and close tolerances demanded in the finishing of such a forging require the most modern machine tools, and great skill and experience on the part of the operators.

Add continuous laboratory control of all operations and one responsibility, and you can see why so many forging buyers place complete confidence in National Forge. They know we will turn out their work 100% to their specifications in a minimum of time and at a reasonable cost.

May we present you with facts on the advantages of having all your forging operations under one responsibility? There is no obligation involved; just write to the NATIONAL FORGE AND ORDNANCE COMPANY, Irvine, Warren County, Pennsylvania.



NATIONAL FORGE
AND ORDNANCE COMPANY
IRVINE, WARREN COUNTY, PA.

Steel Makers *Forgesmiths*
Heat Treaters *Machinists*

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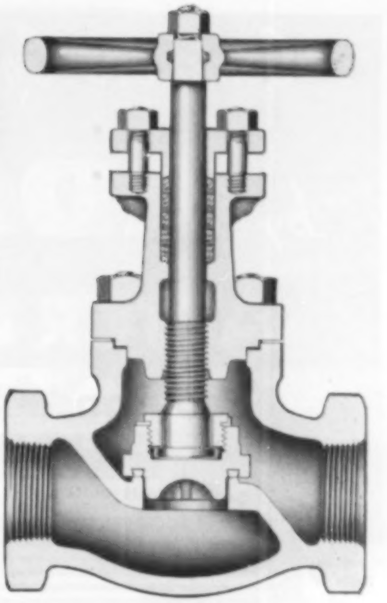
ALL PIPING EQUIPMENT YOU NEED ...FROM ONE SOURCE OF SUPPLY



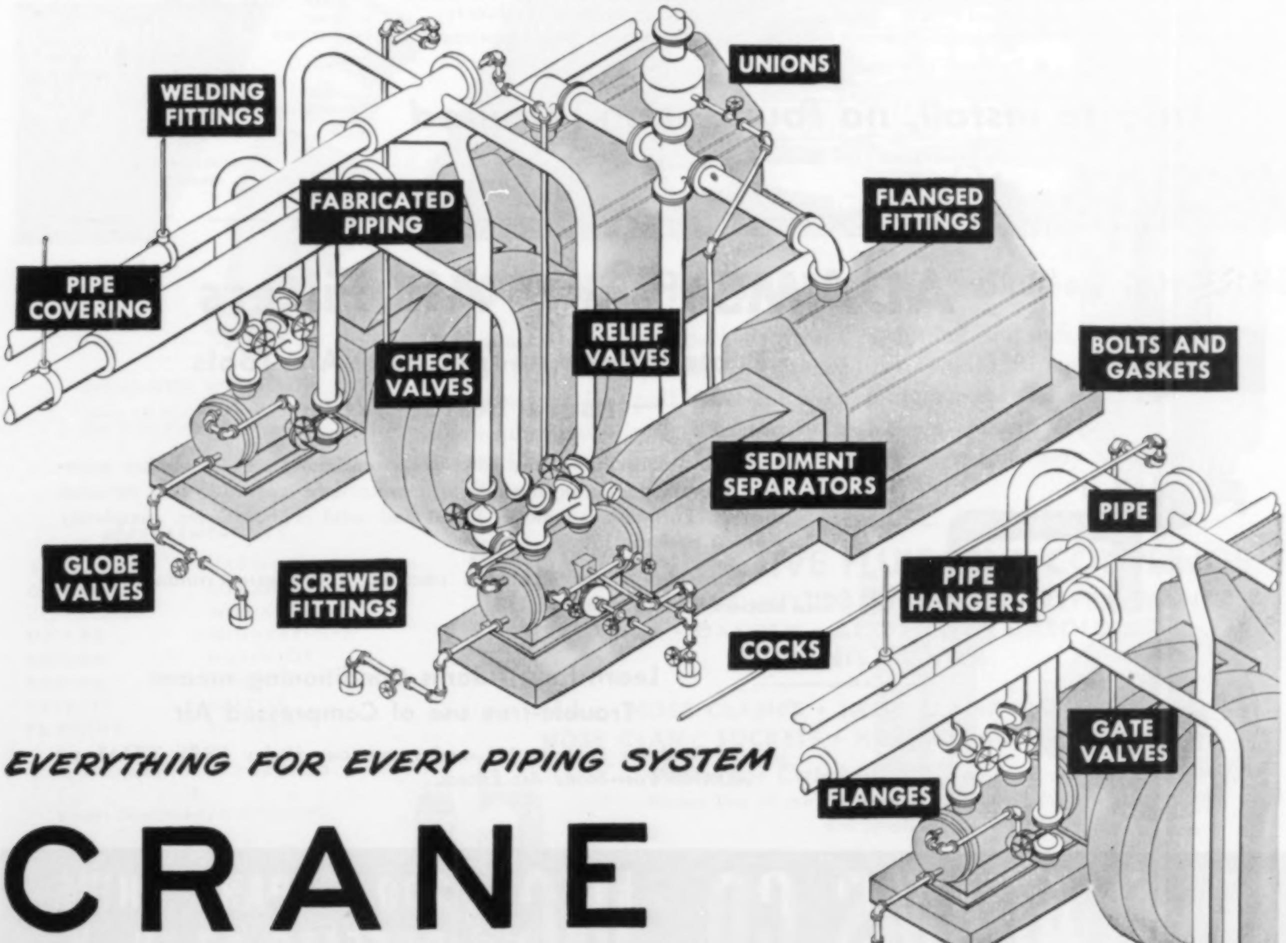
WORKING PRESSURES:
300 pounds ammonia;
500 pounds oil, gas, or air up to 100° F.
Sizes: ¼ to 3 in.; Screwed or flanged ends.

SAFER CONTROL FOR MANY SERVICES, Crane Ferrosteel Globe and Angle Valves—especially designed for high pressure ammonia refrigeration service—also find wide application on air, gas, oil and chemical lines where heavy, all-iron construction is desired. Special Crane seating design, rugged construction, and precise manufacture combine to make these valves safer, more efficient on all heavy duty services.

For volatile and hazardous fluids, these valves are supplied with a lead face disc specially designed for tight seating. For high temperatures and certain corrosive conditions, a case-hardened steel disc and seat can be supplied. Available with tongue and groove flanged ends, or screwed ends with extra long threads, and recessed for soldering. See your new No. 49 Crane Catalog, p. 394-5.

CRANE CO., 836 S. Michigan Ave., Chicago 5, Ill.
Branches and Wholesalers Serving All Industrial Areas

● THIS AMMONIA COMPRESSOR INSTALLATION, FOR EXAMPLE, CAN BE COMPLETELY EQUIPPED BY CRANE



UNIONS
WELDING FITTINGS
FABRICATED PIPING
FLANGED FITTINGS
PIPE COVERING
RELIEF VALVES
CHECK VALVES
BOLTS AND GASKETS
SEDIMENT SEPARATORS
PIPE
GLOBE VALVES
SCREWED FITTINGS
PIPE HANGERS
COCKS
GATE VALVES
FLANGES

EVERYTHING FOR EVERY PIPING SYSTEM

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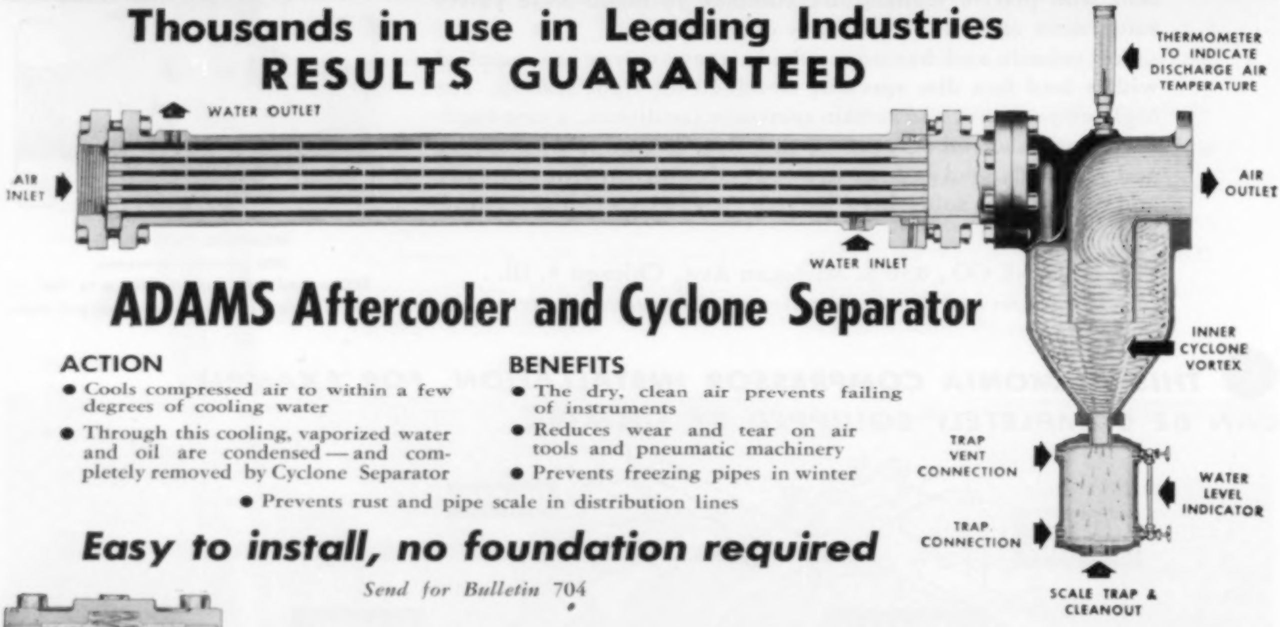
VALVES • FITTINGS • PIPE • PLUMBING AND HEATING

Complete Conditioning of Compressed Air

by ADAMS PIPELINE

AFTER COOLER *and* AIR FILTER

Thousands in use in Leading Industries
RESULTS GUARANTEED


WATER OUTLET
THERMOMETER TO INDICATE DISCHARGE AIR TEMPERATURE
AIR INLET
AIR OUTLET
WATER INLET
INNER CYCLONE VORTEX
TRAP VENT CONNECTION
WATER LEVEL INDICATOR
TRAP CONNECTION
SCALE TRAP & CLEANOUT

ADAMS Aftercooler and Cyclone Separator

ACTION

- Cools compressed air to within a few degrees of cooling water
- Through this cooling, vaporized water and oil are condensed—and completely removed by Cyclone Separator

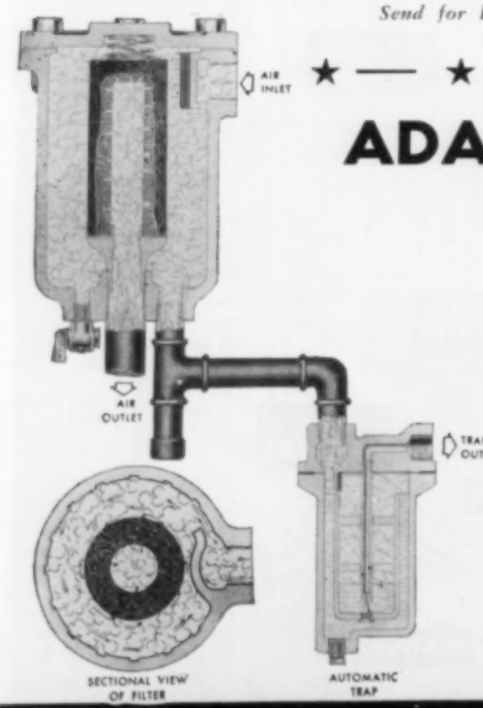
BENEFITS

- The dry, clean air prevents failing of instruments
- Reduces wear and tear on air tools and pneumatic machinery
- Prevents freezing pipes in winter
- Prevents rust and pipe scale in distribution lines

Easy to install, no foundation required

Send for Bulletin 704

★ — ★ — ★ — ★ — ★ — ★ — ★ —


AIR INLET
AIR OUTLET
TRAP OUTLET
SECTIONAL VIEW OF FILTER
AUTOMATIC TRAP

ADAMS PORO STONE Air Filters

Protect Instruments and Air Tools —Insure Better Work

The Adams Poro-Stone Filter gives continuous service without attention or maintenance expense. Efficient centrifugal separation *plus* diffusion through Poro-Stone, removes liquid and solid contamination completely without pressure loss.

Automatic Trap eliminates attention and assures continuous and efficient filter operation.

Learn how Adams Conditioning means Trouble-free use of Compressed Air

Send for Bulletin 105, and accept our 30-day FREE TRIAL on ADAMS Poro-Stone Air Filters.

R. P. ADAMS CO., INC.

209 E. PARK DRIVE
BUFFALO 17, N. Y.

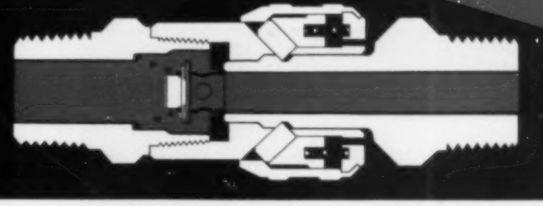
HANSEN

QUICK CONNECTIVE SHUT-OFF COUPLINGS

HYDRAULIC • PNEUMATIC

HANSEN PUSH-TITE COUPLING

Cross-section at upper right shows flow through coupling when connected.

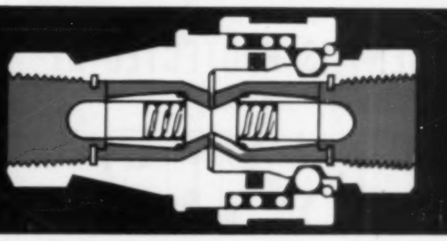


HANSEN *PUSH*-TITE COUPLING *Shuts off one side of line*

Hansen Push-Tite Couplings give you quick connection and disconnection, with instant automatic flow or shut-off. To connect coupling, and open line to flow of fluid, you merely push plug into socket. To disconnect, a slight pull on sleeve releases plug and shuts off supply end of line. Free swiveling plug prevents hose kinks.

HANSEN SERIES HP 8000

Shuts off both ends of line when disconnected.



HANSEN *HIGH-PRESSURE 2-WAY Shut-off* COUPLING

To connect, merely pull back sleeve and push plug into socket. Identical torpedo type valves permit free flow of gas or liquid through coupling. To disconnect, just pull back sleeve—coupling immediately disconnects, valves automatically and instantly seal both ends of line. Can be mounted to disconnect automatically where fluid lines may be subject to sudden, damaging strain.

REPRESENTATIVES

BALTIMORE
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MILWAUKEE
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NASHVILLE
SAN FRANCISCO
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MONTREAL • TORONTO

Export Department: CLEVELAND

QUICK CONNECTIVE FLUID LINE COUPLINGS

AIR • OIL • GREASE • HYDRAULIC FLUIDS • REFRIGERANTS
STEAM • OXYGEN • ACETYLENE • GASOLINE
COOLANTS • WATER

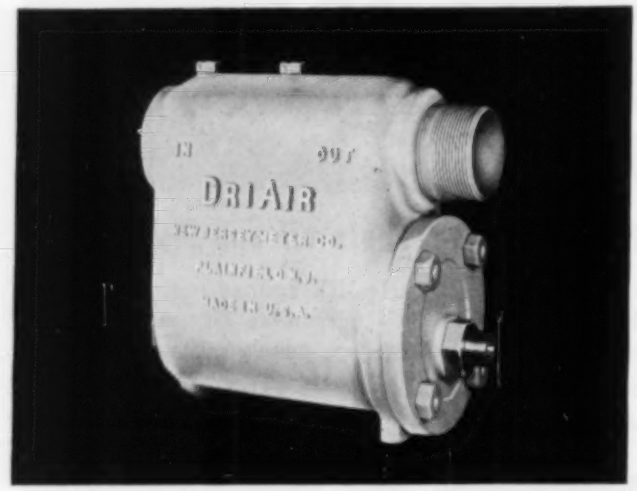
HOSE CLAMPS • HOSE CLAMP PLUGS
HOSE CLAMP SOCKETS • HOSE CLAMP COUPLINGS

Write for Catalog giving descriptions and sizes of complete Hansen line of straight through and shut-off couplings for hydraulic and pneumatic connections.

THE HANSEN MANUFACTURING COMPANY

4031 WEST 150th STREET • CLEVELAND 11, OHIO

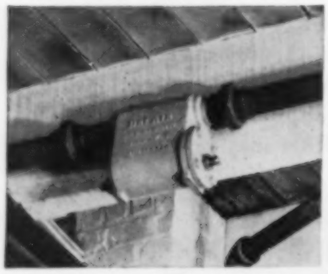
DEPENDABLE PNEUMATIC SERVICE



WHEN EQUIPMENT IS PROTECTED BY

DRIAIR

A COMPLETE SELF-CONTAINED UNIT



DriAir may be installed by suspending it from the piping, without any other support, or may stand on the floor near equipment being protected.

DRIAIR speeds production by separating and automatically ejecting the condensed water and oil from the air. DriAir collects dirt and rust from the air lines and delivers clean dry air to the tools, thus reducing wear and prolonging their life. All internal parts are made of bronze or copper—resistant to corrosion and practically permanent. Copy of Bulletin DA fully describing the operation of DriAir sent on request.

NEW JERSEY METER COMPANY

PLAINFIELD, NEW JERSEY

QUESTION:

Which Garlock rod packing is braided through and through for longer life?

ANSWER:

LATTICE-BRAID

In Garlock Lattice-Braid *every braiding strand* passes diagonally *through* the body of the packing at an angle of approximately 45°. All the strands are strongly lattice-linked together into a structural unit which holds together even when the packing is worn far beyond the limits of wear of ordinary braided packings.

Lattice-Braid packing is manufactured of asbestos, flax or cotton for various types of service. Write for descriptive folder.

The unique structural design of Lattice-Braid packing gives it great strength, long life and unusual flexibility.

PATENTED

THE GARLOCK PACKING COMPANY
PALMYRA, NEW YORK

In Canada: The Garlock Packing Company
of Canada Ltd., Montreal, Que.

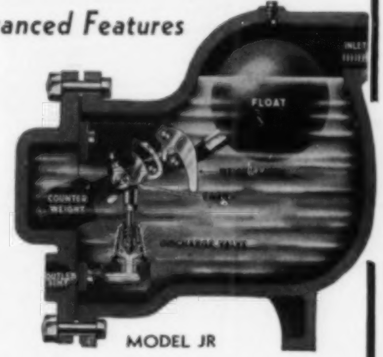
GARLOCK

PACKINGS, GASKETS AND OIL SEALS

Nicholson Air Traps Assure

POSITIVE DRAINAGE OF AFTERCOOLERS

by 2 Advanced Features



MODEL JR

1) Positive Fluid Seal Over Discharge Valve—As a result of this feature Nicholson traps are increasingly specified wherever loss of air is a problem in drainage of aftercoolers, intercoolers, separators, receivers, etc.

2) Extra Large Discharge Capacity—Valve opens wide instantaneously to discharge water, oil and dirt, after which it closes tight—instantaneously.

OTHER TROUBLE-PROOF FEATURES Non-wire drawing; not dependent on float to raise valve; of stainless steel where it counts, to prevent corrosion; rugged, for unavoidable abuse. 3 types for press. to 1500 lbs.

Catalog 448 or see Sweet's

W. H. NICHOLSON & CO. 180 OREGON STREET WILKES-BARRE, PA.

Valves ★ Traps ★ Steam Specialties

COMPRESSED AIR DATA
CAMERON HYDRAULIC DATA

BUY BOTH BOOKS FOR $5.00

Price Individual Books	Per Copy
Compressed Air Data	$3.00
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COMPRESSED AIR MAGAZINE, 942 Morris Street, Phillipsburg, New Jersey.
Please send me:

☐ Compressed Air Data and Cameron Hydraulic Data..Both books for $5.00.

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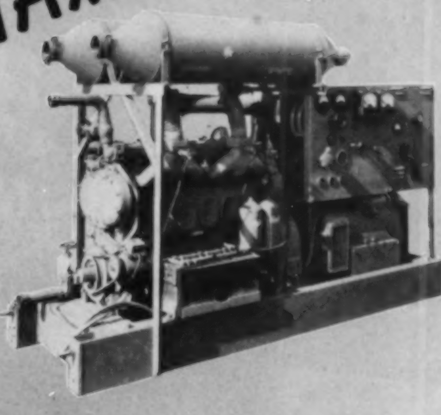
☐ Enclosed is (money order) (check) for $........) ☐ Send books C.O.D. I understand that the books will be sent me postpaid, and that they may be returned within 10 days if not satisfactory.

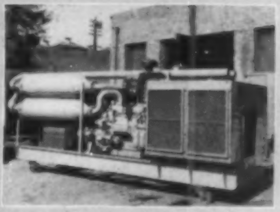
Name ....
Company ....
Street No. ....
City ....State ....Country ....

MAXIM GOES



TO THE MOVIES

This compact, efficient General Motors Diesel generating set built by Anderson-Obrien Co. of Los Angeles packs a powerful punch *quietly* because of the two MU3 Maxim Silencers through which the exhaust passes.



Here are two other generating sets showing a variation in the method of placing the silencers.

Here is a case where quiet power is a "must" because these sets are used for providing power when the moving picture industry goes "on location." Efficient and unfailing power the movie technicians must have, but noise and racket have no part in the making of a picture today. Where portable generator sets are used it is nearly always necessary to provide this power without excessive noise. In this case, however, the necessity for the Maxim quality of silencing is even more obvious.

Maxim Silencers are at work today in many and varied industries. Exhaust silencers, intake silencers, silencers for steam or air discharge and the versatile heat recovery silencers are the accepted standard for *quiet* operation when they carry the famous Maxim name.

THE MAXIM SILENCER COMPANY
61 HOMESTEAD AVE. HARTFORD 1, CONNECTICUT

Please send bulletin on silencers for:

☐ Exhaust ☐ Intake
☐ Spark Arrestors ☐ Heat Recovery

Name ______
Company ______
Address ______

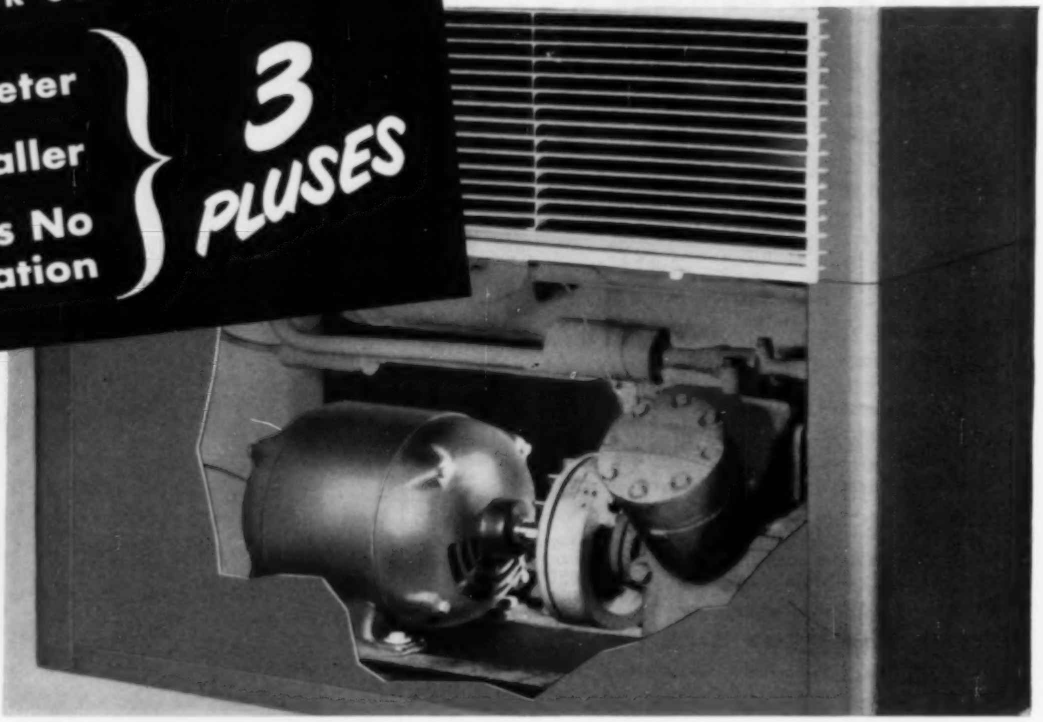
BE SURE IT'S A

MAXIM

YOU CAN BE **SURE**.. IF IT'S
Westinghouse

FOR AIR CONDITIONING

Quieter
Smaller
Needs No Lubrication
3 PLUSES



Only Life-Line offers ALL THREE

Air conditioning equipment should be "felt", not "heard". That's where Life-Line offers builders and users of air conditioning and refrigeration equipment an important advantage.

Ventilating design—the maintenance of exact air gap . . . proper cooling and winding distribution—limit "windage" noise. Dynetric balancing assures absolute smoothness. New manufacturing techniques provide micrometer alignment. Result? A minimum of noise-producing vibration. In fact, you can edge-balance a coin on a Life-Line through a start, run, stop cycle. It's *that* smooth running.

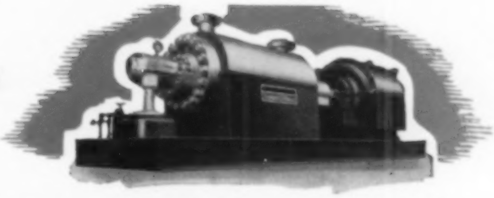
Quietness is but one feature; compactness, another. Life-Line's 1/3 smaller size (over conventional-type motors) is a valuable asset when design allows only limited space. Too, Life-Line needs no lubrication. Install it in "hard-to-get-at" locations . . . crowd it into cramped quarters—and forget it!

Only Life-Line offers all three—quietness, compactness, and lubrication freedom. Why not put them to work? A phone call to your nearby Westinghouse representative will bring you complete details. Contact him now, or write Westinghouse Electric Corporation, P. O. Box, 868, Pittsburgh 30, Penna. J-21578

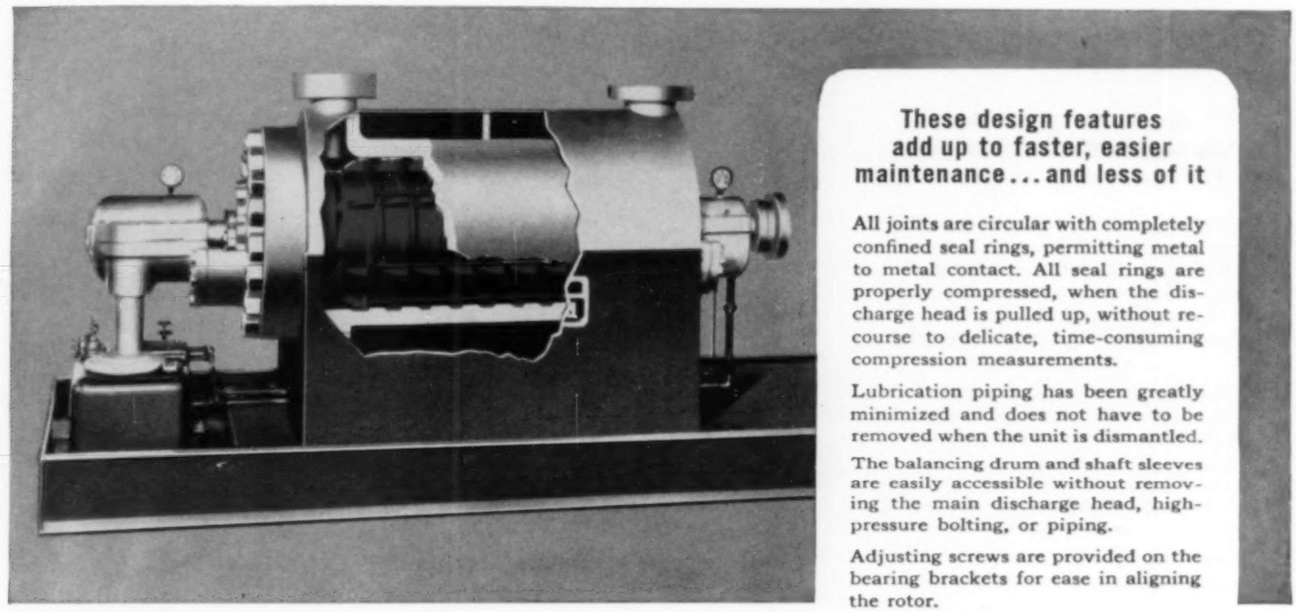
. . . If you figure LIFE-COSTS . . . you'll figure LIFE-LINE . . .

Westinghouse Life-Line Motors
INDUSTRY'S LEADING MOTOR

Here's why Ingersoll-Rand High-Pressure Boiler-Feed Pumps are so much



EASIER TO MAINTAIN



These design features add up to faster, easier maintenance... and less of it

All joints are circular with completely confined seal rings, permitting metal to metal contact. All seal rings are properly compressed, when the discharge head is pulled up, without recourse to delicate, time-consuming compression measurements.

Lubrication piping has been greatly minimized and does not have to be removed when the unit is dismantled.

The balancing drum and shaft sleeves are easily accessible without removing the main discharge head, high-pressure bolting, or piping.

Adjusting screws are provided on the bearing brackets for ease in aligning the rotor.

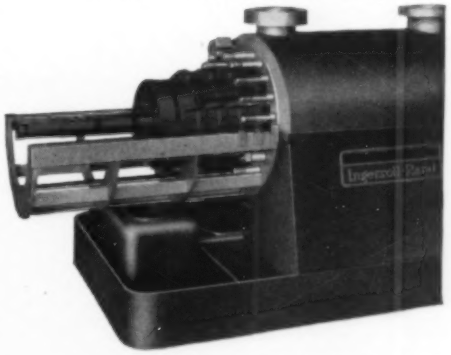
Impellers are individually mounted on the shaft with a slide fit simplifying assembly and permitting interchangeability.

The smothering water connections are on the stuffing-box extensions and no pipes have to be disconnected from the glands when removing them to give access to the stuffing boxes.

Pumping boiler-feed water 24 hours a day, at discharge pressures from 1000 to 3000 psi, is a tough job for any pump. It's a job that calls for extra stamina and endurance—for trouble-free performance year after year.

Ingersoll-Rand double-case pumps meet these requirements—*and more.* Their dependability is a matter of record ... established in many of the outstanding high-pressure installations. However, in addition to being resistant to wear and corrosion, I-R feed pumps are designed for maximum accessibility, thereby greatly simplifying routine inspection and maintenance. You save hours, or even days, of "down-time" for dismantling and assembly operations, too, because the entire inner-casing assembly of these pumps can be easily removed as one complete unit in a surprisingly short time.

For complete information on I-R Class CHTA and CHTB high-pressure pumps call your nearest Ingersoll-Rand branch office.



The inner casing assembly is shown here partly removed from the outer casing. The outer casing remains in its original position during dismantling and assembly, and the discharge and suction piping need not be disturbed.

Whatever the pressure or the capacity, Ingersoll-Rand can supply the *right* boiler-feed pump constructed of the proper materials.

Ingersoll-Rand

391-10 11 BROADWAY, NEW YORK 4, N. Y.

COMPRESSORS · AIR TOOLS · ROCK DRILLS · TURBO BLOWERS · CONDENSERS · CENTRIFUGAL PUMPS · OIL AND GAS ENGINES

Compressor lives longer, works steadier with TIMKEN® bearings

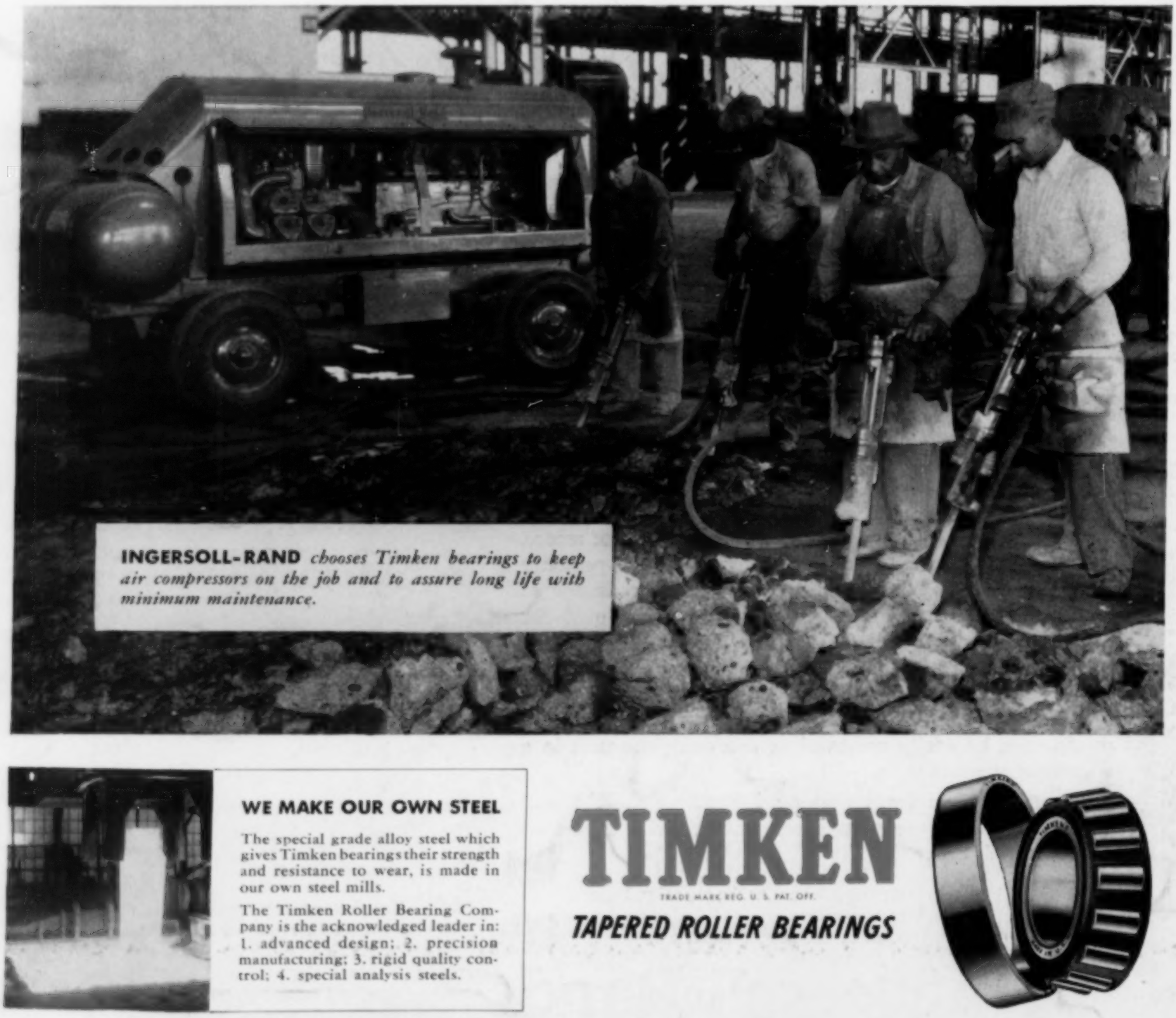
INGERSOLL-RAND portable air compressors have Timken® bearings on the crankshafts to insure long life and uninterrupted service. There's less chance of breakdowns with Timken bearings—less maintenance time and fewer maintenance materials needed.

Timken bearings keep crankshafts in positive alignment, free from excessive deflection and endplay. Wear on surrounding parts is reduced. And because Timken bearings are manufactured to incredible precision, they permit closures that more effectively keep out dirt and retain lubricants.

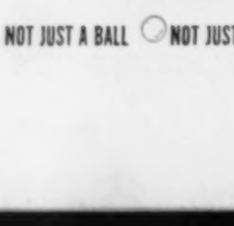
Since Timken bearings are tapered in construction they carry any combination of radial and thrust loads. Line contact between rolls and races provides maximum load-carrying capacity. Timken bearings are made from the finest steel ever developed for tapered roller bearings—Timken alloy steel. Thanks to advanced design and materials, they normally last the life of the machine.

With over 50 years of bearing research behind them, Timken bearings are industry's first choice. No other bearing gives you *all* the advantages you get with Timken bearings. Specify them in the machines you build. Look for them in the machines you buy. The trademark "Timken" is your best guide to quality. The Timken Roller Bearing Company, Canton 6, Ohio. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



INGERSOLL-RAND *chooses Timken bearings to keep air compressors on the job and to assure long life with minimum maintenance.*



WE MAKE OUR OWN STEEL

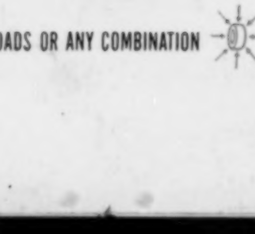
The special grade alloy steel which gives Timken bearings their strength and resistance to wear, is made in our own steel mills.

The Timken Roller Bearing Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER THE TIMKEN TAPERED ROLLER BEARING TAKES RADIAL AND THRUST LOADS OR ANY COMBINATION